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The Institute of British Foundrymen
The Institute of Vitreous Enamellers
The National Ironfounding Employers' Federation
The Welsh Engineers' and Founders' Association
and
The Foundry Trades' Equipment and Supplies Association

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Cost of Co-operation

Several times a year, after the reading of a technical Paper, the participants in the discussion make a plea for closer co-operation between various industries. Such cases have arisen when refractory technologists, blast-furnace managers, electroplating experts, and welding enthusiasts have presented Papers to the Institute of British Foundrymen. Just exactly what the various speakers had in mind when they made reference to co-operation is not easy to interpret or to evaluate. It is evident that, in some cases, all that was desired was a short-circuiting of the buyers and the actual meeting of the individual technicians of the buyer and seller. Such meetings would, of course, do much towards the proper appreciation of each other's difficulties. However, this does not reinforce the technical side of one industry by either the supplying or consuming trades, and it is reasonable to interpret the wishes of many speakers as a desire for fundamental research to be undertaken for the joint benefit of the two industries.

Naturally, such work costs money, and although both parties must benefit, there remains in the background the question of who should pay. We have enumerated four specific cases, and are guided in our conclusions by the time-honoured adage of "paying the piper," or its more modern rider, "the customer is always right." Thus, taking the pleas for co-operation enumerated, we suggest that the evaluation of the properties of refractories used in the foundry industry should be carried out at the expense of the manufacturers of these commodities. A similar condition exists for the products of the blast furnace. In the case of electroplating, it is for the foundry industry to shoulder the burden of the costs for any fundamental research required. The last case, that of welding, is the most difficult, for here are two competing industries, and in any joint investigation as to the development of, say, composite structures, it would seem to be good business to retain at least a 51 per cent. holding in any joint enterprise.

We are aware that it sounds somewhat banal to introduce the question of money into one of the major "ideals" of industry, but we feel it is desirable that this important factor of cost, if not necessarily uppermost, should certainly have a place in the minds of those suggesting co-operation between industries.

Shortage of Managers—2

We remarked last week on a college principal who wished to see more students at evening foundry classes, pointing out that a foundry owner could not get a suitable manager for a four-figure salary. In the past it has been quite sufficient for ambitious young men to prepare themselves for senior posts by attending evening classes. Indeed, in a system of voluntary part-time education, it is inevitable that the majority of students attending should be stimulated to do so by the prospect of getting on. The question is whether this is now enough. Many of the most honoured and respected figures in the industry started on the foundry floor, and their success owes much to their practical knowledge. But they are men who have added experience to personality in the true sense, and who would have made a mark for themselves in any walk of life. This channel of advancement from the foundry floor must be kept open at all costs. But we have to ask ourselves whether, under present conditions, a man can acquire all he needs in this way, and we think it has to be answered in the negative. That is the reason why recently efforts have been made to furnish means whereby a broader training can be obtained.

To the young man destined for foundry work, the University of Sheffield offers a three- or four-year degree course in founding. Followed by appropriate practical experience and what may be termed an apprenticeship to executive work, the training should be valuable. To the young man who has already had practical experience in the industry, and who has marked himself out for further responsibility, the British Foundry School offers a year's course to provide him with that intensive further knowledge and experience he needs, and the contacts which will be of assistance. Naturally, these men have had experience of part-time technical college work, and have reached a suitable standard. In these two ways the industry is fashioning for itself the means for the production of the men who will carry the ever-increasing responsibilities of developing the industry through the next few decades. And while every worker can feel that his knapsack contains the managerial baton, it is no use disguising the fact that evening technical school attendance of itself does not ensure a four-figure job.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Preliminary Costing Report

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to Mr. Kinnell's letter in your issue of February 20, it is possible that the question raised concerning the percentage that the yield of good castings is of the total metal melted will be answered from another source, but it might assist Mr. Kinnell to appreciate that the hypothetical figures quoted in the report are not unreasonable if he obtains from his foundry the information falling under the headings shown below, calls the top line 100 per cent., expresses the other figures as a percentage of this, and compares his results with the imaginary figures I have inserted.

	Tons.
Total weight of metal melted (*i.e.*, charged to cupola)	100
Weight of runners and risers ...	40
Ditto waster castings	4
Ditto good castings	52
Weight of metal not accounted for (weight lost in melting) ...	4
	100

It would appear that, in speaking of a foundry making light iron castings which showed a yield of 70 to 80 per cent. of the total metal melted, the ratio of runners and risers to finished castings has been overlooked.—Yours, etc.,

B. DORAN.

Stanley House,
Barras Lane,
Coventry.
February 21, 1936.

P.S.—In the concluding sentence of that part of the "Criticisms of the Costing Report," which dealt with the application of melting costs to particular jobs (appearing in the same issue, February 20), the words "and waster castings" should be added after "runners and risers."

Cupola Metal Temperatures

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—In the discussion following my Paper, "The Balanced Blast Cupola" (THE FOUNDRY TRADE JOURNAL, January 16), as pointed out there, all temperatures are exactly as observed by the optical pyrometer. This was done in order to get comparison between all the cupolas mentioned, and the data were collected over a number of years.

Temperatures mentioned by others have the advantage of 100 deg. or so of a correction, which accounts for the difference of opinion expressed.

The normal figure for the daily average of temperatures as set out in Table VII is 1,400 deg. C. observed and 1,525 deg. C. correct.—Yours, etc.,

WM. Y. BUCHANAN,
Metallurgist and Foundry Manager.
John Lang & Sons, Limited,
Johnstone, near Glasgow.

Dimensional Changes in Tool Steels

Heat-treatment and hardening of tool steel produce slight changes in their dimensions. E. AMEEN, in "Jernkontorets Annaler," has studied these changes for six different alloy tool-steels employing cylindrical samples of different initial dimensions. It was found that hardening, the hardening temperature and the composition of the steels were principally responsible for the changes observed. The effect of tempering was also studied and showed that under suitable tempering conditions the resulting changes in dimensions could be minimised.

Publication Received

Ryland's Directory. 1936 Edition. — Published by Industrial Newspapers, Limited, 49, Wellington Street, London, W.C.2. Price, cloth bound, £2 2s.; morocco bound, £2 12s.

One would have thought that, in this age of amalgamation and rationalisation, Ryland's Directory would become thinner. Instead of this we find that there are 1,500 new names in the alphabetical section, which extends the list by some 500 insertions, as about 1 per cent. of the firms listed invariably go out of business every two years. The Editors tell us that there have been more alterations than has ever been the case previously. There has been a special effort made in this issue to improve the section dealing with engineers' specialties, in order to extend the headings to bring in the more recently developed ones and to condense under one heading articles which previously figured under several, all of which carried pretty much the same list of suppliers. Switchgear is a typical instance. When we reviewed the 1934 edition we pictured ourselves back in the industry and showed how valuable Ryland's was from the moment of opening the post right through the day, pointing out its utility for deciphering signatures of letters, planning the territory for travellers, enhancing the value of an isolated journey to one small town, aiding the buying department and the drawing office. There is no department of a foundry where, if used intelligently, Ryland's Directory cannot be of help. We have used the word "intelligently" because we confess that it was only in recent years that we discovered that it contained such information as a complete list of coke ovens, gasworks, electricity undertakings, and every railway, both British and foreign. The list of foundries has remained reasonably static, the most important change being the creation of Federated Foundries, Limited. There are comprehensive lists of foundries for all the Dominions, whilst the one detailing the manufacturers of alloyed and high-duty cast iron continues to grow. Comprehensiveness and reliability have obviously been uppermost in the minds of the Editors, and the success attending their efforts is such that we can unhesitatingly recommend it wholeheartedly to our readers.

Electrometric Analysis

Continuing their series of Papers dealing with the applications of electrometric analysis in steelworks laboratories, P. DICKENS and G. MAASSEN, in Report No. 286 of the Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung zu Düsseldorf, describe in detail experimental work relating to the estimation of cobalt and manganese with the aid of potassium ferricyanide. The authors give a new volumetric method for the electrometric estimation of cobalt in ammoniacal solution containing ammonium citrate, by oxidation with potassium ferricyanide. Advantages of this method are that it can be applied without excluding air, and that the ferricyanide can be readily determined by titration with cobalt-nitrate solution. The many difficulties to be overcome before the method could be made suitable for routine steelworks analysis have been successfully overcome. Cobalt can be estimated also in the presence of nickel. The manganese estimation is based on the same reaction as cobalt estimation, and in electrometric analysis both metals are estimated together.

ANOTHER ORDER for a cargo steamer of 9,300 tons for Messrs. W. H. Cockerline & Company, Limited, Hull, has been received by Messrs. William Gray & Company, Limited, West Hartlepool. The firm now has nine vessels on order.

Outlook for Copper

By "ONLOOKER."

Of the four non-ferrous metals, copper was the most fancied for a rise in price with the advent of the new year, for lead and spelter had their fling in the autumn, while tin, in the face of an increasing output, was fairly obviously destined to reach a lower level before it could hope to stage a recovery. Actually market opinion in some directions foresaw a rise in the value of standard copper to £40 before Christmas, this view being based mainly upon the expectation that speculators would come in again strongly on the bull tack. This hope has not matured, for the speculator has shown himself to be rather shy of copper futures, and his interest still lags for want of something really tangible to go for. Statistically the position is not improving quite so rapidly as the friends of copper expected it would, and there has been some disposition—unwarranted the writer thinks by the facts of the case—to believe that observance of the curtailment pact is not being too strictly maintained.

This disappointment over the statistical position is not unnatural, for with a cut in output at the rate of 240,000 short tons per annum the seven months which have elapsed since the pact was instituted might well be expected to have brought about a bigger change for the better than they have. What there is to remember in this connection, however, is that the reduction in production was calculated on the rate current on January 1, 1935, and during the period of negotiations which preceded the adoption of the cut producers were jockeying for position and lifted their output accordingly. The result of this was that production during 1935 surpassed the tonnage in the previous year very materially, and although consumption fortunately increased, too, the net improvement in the statistical position was certainly not what had been expected.

A few months ago U.S. mines made an increase which seems to have been rather unwarranted, for stocks in North America have shown a rising tendency of late, and the prospects of lifting the domestic price beyond 9¼ cents suffered in consequence. With it all, however, the all-round rate of production in the United States is not much more than 20 per cent. of capacity, a fairly clear indication that there is ample room for improvement in that country.

As things stand at the moment neither London nor New York seem to be capable of leading a sustained advance in the copper price, or perhaps it would be more correct to say of initiating a real upward trend, although once a start were made there is little doubt that the two markets would react on each other and foster a spirit of optimism sufficient to drive the quotation up to 10 cents. This sounds rather speculative and not very convincing or reassuring to trading interests, manufacturers in particular, who must naturally ask themselves whether the present position does really justify such an advance in the price. To judge from recent utterances by prominent personalities among the producers, it hardly seems as if a much higher quotation is at present a reasonable proposition, for one certainly derives the impression that costs are well below the London Metal Exchange price, and that producers, or at any rate a great many of them, are not dissatisfied with the profits they are now making.

Nevertheless there is an appearance of very considerable strength about the London market which augurs quite well for the future, and it is, of course, an open secret that in spite of opposition from at least one big producer, there is quite a strong movement in favour of raising the price to a more remunerative level.

Cast Iron for the Manufacture of Glass-Bottle Moulds*

By N. L. EVANS, B.Sc., A.I.C., W. GOACHER, A.M.I.Mech.E., A.M.I.P.E., and J. E. HURST

[ABSTRACT.]

Material for glass-bottle moulds requires to have good casting and machining properties and be capable of taking a fine polish, and at the same time must be resistant to heat and should scale as little as possible. The use of expensive alloy irons cannot usually be justified and very satisfactory results can be obtained by the use of properly-selected refined pig-irons.

The moulds considered in this Paper are the parison mould and the blow mould, but the data on suitable irons are applicable to all moulds used in the glass industry. The glass entering such moulds has a temperature of 900 to 1,000 deg. C., and the moulds themselves reach a temperature of approximately 500 deg. C. on the inside. The skin temperature on the inside, however, must be much higher than 500 deg. while the hot glass is actually in contact with it, as it is sufficient to cause scale to form on the iron. As the moulds are air-cooled on the outside, there is a considerable temperature gradient between the inside and the outside which sets up fairly considerable stresses in the iron.

Moulds in continuous use last longer than those used intermittently for making the same number of bottles. This is explained by the mechanism of growth in cast iron. Growth is due partly to the breakdown of iron carbide in cast iron which takes place at a temperature of about 600 deg. C. or over. The stable condition of cast iron is a mixture of iron and graphite, and the change to this from iron carbide is accompanied by an increase in volume, the density of iron carbide being about 3½ times that of graphite. Growth tends to start cracks in the iron which act as channels along which oxidation will occur, causing still further increase in volume; alternate heating and cooling accelerates the formation of cracks on account of expansion and contraction. Graphite flakes which penetrate to the surface of the iron will also act as channels for oxidation.

Refined Irons

When using refined irons for making glass-bottle moulds, the composition should be adjusted to minimise growth. The total carbon content of the iron should be low in order that graphite flakes may be as small and as few in number as possible. The silicon should be present in sufficient amount relative to the thickness of the castings to produce approximately an all-pearlitic structure, that is, with no ferrite or iron carbide in the free state. The Brinell hardness of such an iron is usually between 215 and 235, and it can be readily machined. It is recommended that the phosphorus should not exceed 0.45 per cent., as there is some evidence that this element in larger proportions has a deleterious effect on iron subjected to high temperature. Manganese should be fairly high as it helps to produce a fine-grained structure, and sulphur should be kept as low as possible and not exceeding 0.07 per cent. While it is true that sulphur tends to stabilise iron carbide, its tendency to segregate in the form of mixed iron and manganese sulphides often produces unsoundness in the casting and hard patches difficult to machine.

The sodium-carbonate process for reducing the sulphur and refining the structure of the metal was fully described. This process agitates the metal in the ladle, thus assisting the removal of dissolved gases; and the slag has a scouring action removing undesirable non-metallic inclusions. Most refined irons receive this treatment in the course of manufacture, and it need not be repeated if the metal is crucible-melted for making the castings, but if it is melted in the cupola it is very desirable that the remelted iron should be treated in order to counteract the absorption of gases and the sulphur pick-up from the coke, which are practically certain to take place by this method of melting.

It is worth noting that for crucible melting, refined irons can usually be obtained in the form of specially small pigs, more convenient than the usual larger pigs.

A suggested specification for iron for glass-bottle moulds is as follows:—T.C., 3.1 max.; Si, according to thickness of casting; Mn, 0.8 to 1.5; S, 0.07 max. and P, 0.45 per cent. max. The variation in silicon content in relation to the prevailing thickness of the casting was shown by a chart (Fig. 1), and the method of calculating the correct proportions in which to mix different grades of refined pig-iron was fully explained, both for cupola and crucible melting.

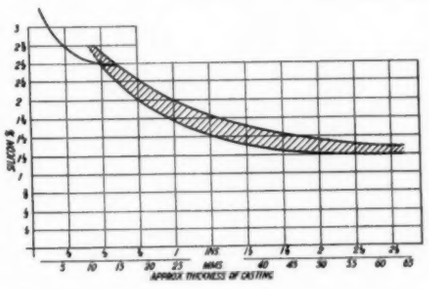


FIG. 1.—VARIATION IN SILICON CONTENT IN RELATION TO THICKNESS OF CASTING.

* A Paper read at the Sheffield Meeting of the Society of Glass Technology on February 19, 1936. The authors are respectively associated with Imperial Chemical Industries, Forster's Glass Company and Bradley and Foster.

A Novel Moulder's Spat

We have before us a type of moulder's spat which possesses a number of novel qualities. It has been sent to us by H. G. Sommerfield, Limited, of 7, Tavistock Place, London, W.C.1. It consists of a single piece of substantial leather provided with two clips, reminiscent of those used by cyclists for attaching to trouser legs in order to eliminate flapping. The uppermost clip, attached to the spat by three rivets, terminates in two soft rubber collars at each end, and fits snugly round the ankle; the lower one, of smaller size, fits across the instep. It is evident that attachment and removal of the spat are virtually instantaneous. There is no "left" and "right," and in many cases the wearing of one spat gives adequate protection to metal pourers. The spats are extremely light and give the necessary protection to the instep, whilst a point which is really beyond our province is that the price is extremely modest. We have made this exception in referring to price because of the humanitarian concept of "safety-first" appliances.

A BLAST FURNACE was put into operation at the Cleveland Works of Messrs. Dorman, Long & Company, Limited, Middlesbrough, recently. The furnace is the first of five which the company proposes to restart within the next few weeks. Two other furnaces are to be put out for reconditioning.

Iron and Steel Trade with Lithuania

The Department of Overseas Trade has issued a Report* "Economic Conditions in Lithuania" (November, 1935), by H.M. Consul at Kovno. In regard to trade conditions the Report states that an outstanding feature is the gradual control by the State of all export and import trade during recent years which has resulted in the better organisation of the export trade of the country. It is on the volume of these exports that the prosperity of Lithuania naturally depends. Since 1931 prices realised abroad have constantly fallen, and in 1934 Lithuania had to export approximately the same volume of merchandise as in 1931 in order to realise half the value. The market for imported goods has consequently been severely curtailed during the past five years.

There has been some growth of industry which exists, however, on a comparatively small scale, employing only about 20,000 workers. Here, too, there is a tendency to unification by means of combines in some of which the government has a controlling interest. The Report contains an analysis of the country's foreign trade and the principal individual commodities featuring in both import and export trade are dealt with in detail. It also deals in detail with finance, industry, agriculture, transport and with certain social questions of general interest.

In the iron and steel trade the Iron Importers' Association was formed, at the instigation of the government, soon after the signature of the Anglo-Lithuanian Trade Agreement, in August, 1934. It comprises representatives of the leading industrial consumers and merchants and is empowered by the government to regulate imports of iron and steel. The trade department acts in accordance with the recommendations of the Association, which distributes orders in various foreign countries in the light of the government's undertakings and the exigencies of the trade. It appears to be the practice to purchase in the United Kingdom all classes of steel, including wire, sheets up to 0.75 mm. thick, hoop iron up to 1 mm. thick, iron and steel pipes and tubes for drainage-water supply and central heating; rails and pig-iron. Other European countries receive orders for bars, sheets, iron over 0.75 mm. thick and hoop iron over 1 mm. thick.

The hardware industry comprises four works in Kaunas, including an ironfoundry. The principal articles manufactured are: window and door fittings, locks, chains, screws, bolts, rivets, nails, hammers, axes, spades, kitchen utensils, central-heating installations, ploughs, fencing and barbed wire. One of the factories also has a galvanising plant where imported black sheets are galvanised for roofing purposes and buckets are manufactured. Another factory has an enamelling plant and produces enamelled ware. A railway workshop, belonging to the government, manufactures safes and strong boxes.

Catalogue Received

Metal Spraying.—The Gilford Sales Corporation, of 420, Lexington Avenue, New York City, has sent us a folder which describes a process of "Plymetal" deposit. It is not a gun but a fixed tool which sprays about 12 to 15 lbs. of steel or 25 to 35 lbs. of copper per hr. All the inputs, wire, acetylene, oxygen, are metered into the machine. It is used for building up worn parts as well as for coating, with the object of inducing corrosion resistance and the like.

* No. 632. H.M. Stationary Office, Adastral House, Kingsway, London, W.C.2. (Price 11d. post free.)

Sheffield Foundrymen's Annual Dinner

SIR RONALD MATTHEWS ON FOUNDRY TECHNOLOGY

The value of the work of the Institute of British Foundrymen was well proved by the fact that it now had a membership of nearly 2,000, observed Sir Ronald Matthews (chairman of Turton Bros. and Matthews, Limited), in a speech at the annual dinner of the Sheffield Branch of the Institute of British Foundrymen, held at the Grand Hotel, Sheffield, on February 14.

Sir Ronald proposed the principal toast of the evening, that of "The Institute of British Foundrymen and the Sheffield Branch." He complimented the Branch upon its activities, and said that the degree course in foundry practice at the University of Sheffield was the only degree course of its kind in this country, if not in the world. When they remembered also the work that was being done in regard to the City and Guilds Institute and the series of examinations in foundry practice and science, and in patternmaking, it was very clear that the Institute was a very live body and serving an extremely useful purpose. He had no doubt that in course of time the certificates that the two bodies named would jointly issue would be accepted definitely as the hall-mark of real knowledge in the whole craft and science of foundry technique.

Demand for Skilled Craftsmen

Speaking of industry in general, Sir Ronald said it was a serious thing that, in spite of a very large number of unemployed persons in the country, there was at present a shortage of skilled men in practically every industry. As trade improved, and the demand for skilled craftsmen increased, the country would find itself in a very difficult situation. All through the slump the new entrants into those trades that demanded long periods of apprenticeship had been very few, and the country would definitely feel the disadvantage of this in the future. So far as the foundryman's craft was concerned, the Institute was doing everything within its power to ensure that the shortage should be removed at the earliest possible moment.

Continuing, the speaker said that the presence in the chair of Mr. Arthur Whiteley (Branch-President) was an indication that those engaged in the casting of metals were fully aware of the important part that the refractories industry of the country was playing in helping them to carry out their business with the maximum amount of efficiency. They ought to be proud of the way the refractories industry had kept pace with the steel industry of the country. There had been extraordinary developments in the practice of steelmaking during the past few years. The demands of the steelmakers had become more and more exacting, and but for the way the refractories industry had kept pace with them, the steelmakers would not be in the position they were to-day. He wished the Institute many years of useful work, and hoped that they would make still further contributions to the great science of steelmaking, on which the prosperity not only of Sheffield, but of the whole country, so very largely depended.

The CHAIRMAN, responding to the toast, said that, although the membership of the Institute had risen from 1,780 in April last to 1,820, the present figure, this was not regarded as sufficient. He believed there were more than 3,000 ironfoundries in the country, which meant that the Institute did not represent one member per foundry, let alone the non-ferrous side. He believed that the Council of the Institute were making a big drive to increase the membership, and he could assure them that the Branch would do all they could in this direction. The Sheffield Branch had played an important part in the history of the Institute, and since the Institute had been formed 32 years ago as the British Foundrymen's Association, Sheffield had provided six National Presidents, including Mr. J. E. Hurst, the present President; Mr. Goodwin, the late Mr. Tom Firth, the late Mr. Whittle, Dr. Longman and Mr. V. C. Faulkner.

The Foundry Degree Course

The toast of "The City and Commerce of Sheffield" was offered by Mr. J. E. Hurst (President of the Institute), who said that the annual conference held in Sheffield last year would be a memorable one in the annals of the Institute. Referring to the work done at Sheffield University, he thought there was no other city in the country whose university was so closely connected with the daily pursuits of the individual citizens. Another link had been "cast" in this connection by the establishment of the foundry degree course, with which many of those in the Institute were very closely concerned. It was largely at the instigation of the Institute that this development had taken place.

The DEPUTY LORD MAYOR OF SHEFFIELD (Alderman P. J. M. Turner) and the MASTER CUTLER (Sir Samuel Roberts, Bt.) acknowledged the toast.

The DEPUTY LORD MAYOR said that the foundry degree courses would make it possible for foundrymen to acquire the highest technical knowledge of their craft.

The toast of the guests was offered by MR. J. ROXBURGH (Senior Vice-President of the Branch), and MR. F. M. FISHER (President of the Refractories Association) responded.

A.F.A. Safety and Hygiene Section

With a view to making more effective the work the American Foundrymen's Association has carried on for a number of years, on plant safety, good housekeeping, and protection of foundry workers, a safety and hygiene section has been organised to accomplish the following purposes: To determine further the extent of hazards to safety and health in the foundry industry; to study causes of hazards and methods of prevention, and to provide further protection to workers against exposure; co-operation with other centralised agencies of industry confronted by similar problems, in assembling and making available information on this subject; co-operation with public health agencies, insurance carriers, and the medical profession in forwarding health measures; assisting in standardisation of dust elimination equipment and improvement of shop operating conditions in the foundry industry through active educational work; promoting standards for dust elimination and control equipment, in co-operation with agencies of the manufacturers of such equipment, and giving encouragement by active means where enactment of equitable and fair compensation laws is sought in industrial states.

Mr. E. O. Jones, for many years associated with Belle City Malleable Iron & Racine Steel Casting Companies, Racine, Wis., and for the past three years consultant of Industrial Relations Bureau of the National Founders' Association, has been made director of the Safety and Hygiene section, and will have his office at the headquarters of the American Foundrymen's Association, 222, West Adams Street, Chicago. Mr. Jones is widely known through his work with national and state organisations, groups and committees in the study of industrial dust problems. He has made surveys of hundreds of foundries and prepared reports on conditions. In all this work he has maintained contacts with national and state departments of health, with state industrial commissions and with research organisations interested in this problem. He is eminently qualified to render a valuable service to the foundry industry.

A plan has been arranged with the Saranac Laboratory of the Edward L. Trudeau Foundation for research and consulting service. Under this arrangement the services of Mr. D. E. Cummings, Field Director of the Saranac Laboratory, can be secured by individual foundries or groups of foundries, through the Safety and Hygiene section of the American Foundrymen's Association, for consultation or discussion of general policies dealing with medical and engineering control procedure designed to protect the health of foundry workers. The service which the American Foundrymen's Association now offers to its members under the direction of Mr. Jones will fill the need for a service of this character, and will enable the foundry industry to co-operate with similar agencies in other industries, in a helpful and constructive way. The Association is inviting the co-operation of all those interested in industrial safety and hygiene, and advises that it has available for those who desire them copies of a 30-page pamphlet reporting the session on "Good Housekeeping" of the 1933 Chicago convention. Also available for distribution are copies of a 64-page report of Papers on "Dust Control and Employer Responsibility" presented at the 1935 convention held at Toronto, Canada.

American Exchange Paper to International Congress

Mr. Johannes Erler, metallurgist, Farrel-Birmingham Company, Ansonia, Connecticut, has been selected as the author of the American Foundrymen's Association Exchange Paper to the International Foundry Congress in Düsseldorf, September 15 to 20, 1936. The Paper will be entitled, "Studies of Casting Stresses in Chilled Iron," and will deal primarily with stresses existing in chilled iron rolls.

MR. J. ERLER.

Mr. Erler has had a wide experience of industry. Born in Leipzig, Germany, in 1900, he received both his preliminary and advanced education in that country. He attended Berg Akademie, Freiberg, Germany, and began his industrial career in America in 1926 when he became associated with the Carus Chemical Company, La Salle, Ill., as chemist. He remained there until 1928, when he took a position as metallographist at the Wilson Foundry & Machine Company, Pontiac, Mich., where he remained for two years. In 1930 he accepted a position as sales engineer with the Eastern Clay Products Company, Buffalo, N.Y. Two years later he became metallurgist, Farrel-Birmingham Company, Ansonia, Conn., the position he now holds.

Mr. Erler is a member of American Foundrymen's Association, and at present is serving on the Alloy Cast Iron Committee and on the Sub-Committee on White and Chilled Alloyed Cast Irons. He also is a member of the American Society for Testing Materials and the Verein Deutscher Giessereifachleute, Germany.

The Institute of Metals

The twenty-eighth annual general meeting of the Institute of Metals will be held in London on Wednesday and Thursday, March 11 and 12, at the Institution of Mechanical Engineers, when the new President, Mr. W. R. Barclay, O.B.E., will be inducted into the chair. The annual dinner will be held at the Trocadero Restaurant on Wednesday evening. In the evening of Tuesday, March 10, there will be held a discussion on "Metallic Wear." This will be opened with a Paper by Dr. H. W. Brownsdon. Tickets admitting to the meetings may be obtained on application to the Secretary of the Institute of Metals, 36, Victoria Street, London, S.W.1.

The Possibilities of the Electric Furnace in the Cast-Iron and Brass Foundry*

By A. G. ROBIETTE, B.Sc.

Development of the Electric Furnace for Cast Iron

The application of the electric furnace to the production of grey- and malleable-iron castings is by no means a new development. It is not too much to say, however, that it has not yet been accorded, in this country, the prominence or consideration that it possibly deserves. It is now nearly twenty years ago since Elliott demonstrated, by duplexing cupola metal in a basic-arc furnace, that it was possible to obtain a vastly superior product from the point of view of strength and density, by a simple refining operation. Since then, commendable pioneer work has been done by Kerpely, Williams and Terry, and others.

In America, and to a lesser extent in Germany, the development of the electric furnace is a matter of everyday routine in many foundries, the remarkable advances that have been made in recent years are more than emphasised.

The rigid control of composition, pouring temperature, and other melting conditions which are not only possible, but readily attainable, in the electric furnace has done much to show the foundryman what physical properties his products are capable of reaching, and has thus played a not inconspicuous part in this striving after superior or high-duty irons. It should also be remembered that the increasing stringency of specifications for materials of construction, especially in the automobile and allied industries and the rapidly encroaching competition of steel parts, such as forgings, pressings and welded assemblies, gave much-needed encouragement to progress in the metallurgy of cast iron.

Photos by Courtesy of Birmingham Electric Furnaces, Limited.

FIG. 1.—TOP-CHARGING 'LECTROMELT FURNACE, SHOWING THE ROOF REMOVED AND SWUNG TO ONE SIDE READY FOR CHARGING.

FIG. 2.—350-LB. BIRLEC-DETROIT ROCKING ARC FURNACE INSTALLED IN THIS COUNTRY FOR SPECIAL IRONS.

for this purpose grew, especially with a fuller knowledge of the effects of superheating upon graphite formation; with the increasing use of expensive alloying elements; and with the realisation that cheap light scrap could be utilised as one of the main raw materials.

When one looks back upon the handbooks published only 15 years or so ago, and finds that the tensile strength of a high-quality iron was stated to range from 9 to 11 tons per sq. in., whilst to-day the production of unalloyed high-strength irons of from 18 to 23 tons per sq. in.

* A Paper read before the London Branch of the Institute of British Foundrymen, Mr. F. O. Blackwell presiding.

Types of Furnaces Employed

Perhaps it would be as well to make a cursory survey of the electric-melting plant, which has been used with considerable success for cast-iron melting. The arc type of furnace is almost universally used for this work. The early pioneers employed what may be called the hearth type of furnace so familiar in steel-melting practice, and as typified by the 'Lectromelt and Héroult furnaces. The hearth is a refractory-lined, shallow receptacle over which are generally suspended three vertical graphite or carbon electrodes, projecting through a roof usually of silica brick. The electrodes are arranged to move independently of one another, and are commonly driven by motor-operated winches. The movement of the electrodes serves to vary the amount of power liberated in the furnace. On all furnaces above 5 to 10 cwts. in capacity, the electrodes are invariably regulated automatically. These furnaces are all of the tilting type, and they are arranged to tilt forwards for pouring into ladles or shanks and backwards for removing slag, if required, or for patching or fettling the hearth refractories. Sometimes the furnace is arranged with its tilting axis in line with the pouring spout, so as to pour accurately into a receiver, and from there directly into moulds if a continuous conveyor casting system is in operation. The furnace is charged with molten or solid metal from a door diametrically opposite the pouring spout. When melting cold charges on a batch basis, rapid charging, which is a special feature of modern plant, is facilitated by the use of agitated shutes or pans. On larger units the roof is preferably made removable, the whole charge placed in a drop-bottom bucket dumped into the furnace all at once. In this manner the time from power-off to power-on has been reduced to .5 to 10 min., consequently improving the load factor and melting efficiency.

Acid Furnaces Used

The majority of furnaces for plain melting or duplexing are acid lined throughout. The hearth is of sintered quartzite or silica brick, whilst the side walls and roof are of similar materials. In a so-called basic-lined furnace, which is only rarely used for cast iron, when high chromium or manganese compositions are melted, it is only the hearth and lower side walls which are built of magnesite brick or rammed dolomite, the roof and upper side walls being still of silica. The roof, which is the least durable part of the furnace, is made removable for easy replacement. The furnace is fed by a 3-phase supply, generally stepped down on a transformer from an E.H.T. line. Modern furnaces have a high rate of power input per unit of capacity to ensure rapid melting down of the charge, and the transformers are provided with adjustable reactances and voltage tappings, the latter being varied during the heat to lower the power once the metal is molten, and thus prolong the life of the refractories. These fur-

naces, which are in use in sizes from ½ ton to 20 tons or more in capacity, are generally arranged to melt a full charge in 1½ to 2 hrs.

Rocking Arc Furnaces

The other type of furnace extensively employed for this work is typified by the Detroit rocking-arc furnace, which was first used for non-ferrous foundry work and later adapted for the melting of ferrous materials. It is a radically different design of plant from that previously discussed. It has a horizontal cylindrical- or drum-shaped body on the axis of which enter two graphite electrodes. The body is arranged to rock through a varying angle about its horizontal axis. The shell is lined with a rammed, precast monolithic, or segmental-brick lining which may be made acid, neutral or basic to suit the particular melting conditions. Several types of material have been used for cast irons, including sillimanite, alundum, and magnesite. It has a single charging door which is combined with the pouring spout. The furnace is built in sizes taking a charge of from 40 lbs. up to 3,000 lbs., and sometimes larger. It is generally rated so that a charge is melted in approximately one hour from charging. The electrical equipment comprises a step-down transformer arranged with voltage tappings chosen to give the required arc

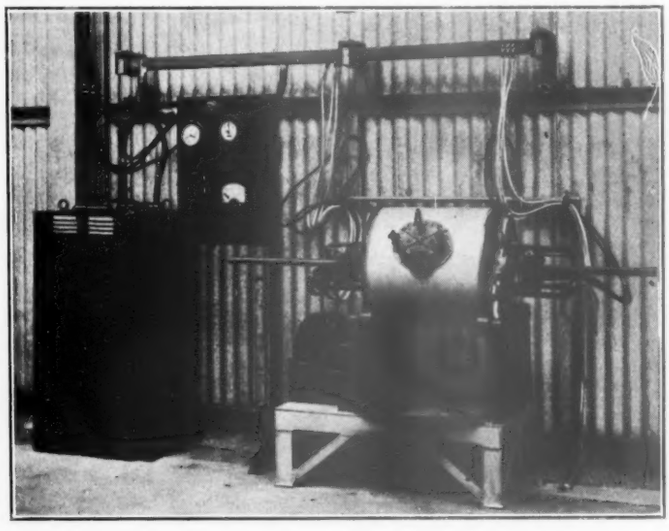


FIG. 3.—SMALL-MODEL—35- TO 80-LB. CAPACITY—BIRLEC-DETROIT ROCKING ARC FURNACE FOR DEVELOPMENT WORK.

conditions. The unit is made practically gastight, enabling light scrap to be melted with a very low oxidation loss, whilst the rocking motion is particularly advantageous when complex alloy cast irons are being melted. It is most popular in sizes of 350, 500, 1,000 and 2,000 lbs., whilst the smallest model having a cold-metal capacity of 40 to 50 lbs. and a molten capacity of 80 lbs. is particularly valuable for development or research work on a semi-industrial scale.

Melting Practice

Before attempting to discuss the relative merits and applications of these two different types of plant, it is proposed briefly to outline the various methods of processes which have been employed for the production of iron castings from these furnaces.

The first obvious method of operating the furnace may be called cold-batch melting and merely consists in charging the material, melting and superheating to the required temperature and then emptying the furnace completely before the insertion of a second charge. Pig is rarely used in large proportions since one of the advantages of the electric furnace is that it can utilise cheap scrap, even borings and steel turnings, thus rendering the process economical even for irons which do not strictly come within the classification of high-duty or special irons. No slag is normally employed as the atmosphere can be made reducing, so that there is a minimum of oxidation loss. This mode of melting is the rule in all jobbing foundries where a range of different compositions are cast daily.

In the electric furnace it is possible to pour several compositions from a single heat. For instance, if four different compositions were required, a base charge would first be melted and adjusted in composition to suit the first cast. Then if the carbon or silicon had to be lowered mild-steel scrap is added, or if these elements are to be increased, coke or ferro-silicon additions are made. Finally, the alloy irons are cast by suitable adjustments in composition. This, of course, is only made possible by the fact that the composition can be accurately controlled and there is a negligible loss of alloying elements. The cold-batch method of melting is recommended for synthetic irons made from steel scrap and for highly-alloyed compositions, since greater attention can be paid to each melt.

Semi-Continuous Operation

The second method of furnace operation is what may be called continuous cold melting. In this case a fairly large bath of metal is built up and when the furnace is full pouring is started. The weight of metal poured is only a small proportion of the total content of the bath (from $\frac{1}{10}$ to $\frac{1}{20}$ by weight), and this pouring is continued at short regular intervals, say every 10 or 20 min. After each pour a corresponding addition of cold metal is charged to the bath. The process is actually semi-continuous, but it results in a very regular flow of metal to the moulding floor and is very conveniently adapted to a conveyor-pouring system for the mass production of similar castings. Its great virtue lies in the fact that there is always a large reservoir of metal to meet varying exigencies, whilst it enables the composition to be maintained within very narrow limits. The process has been very successfully employed for cylinder block and head castings, as well as for stove plates for electric and gas cookers. It is rather less efficient than cold-batch melting owing to the fact that the large bath of metal is kept continuously at temperature whilst refractory costs are also increased.

Duplexing

Then there is the much debated process of duplexing, wherein cupola or air-furnace metal may be poured into the electric furnace and therein refined, a small proportion of steel scrap or other additions made, and the metal superheated to the desired degree before casting. Use is made of the cheapness of cupola melting whilst retaining many of the advantages of the electric-furnace process. This may also be done on the batch or continuous principle. For instance, a certain charge is transferred to the electric furnace by way of a launder, treated and then poured before a second feed of molten metal is made. Or, on the other hand, a large bath of molten metal may be retained in the electric furnace and alternate feeds and casts (each being a small proportion of the bath) made at short regular intervals.

The first method is obviously more applicable to jobbing or miscellaneous work, whilst the second has certain advantages for mass production. The main advantage of duplexing is that the running and initial installation costs are relatively small compared with cold melting. A furnace which will produce, say, 1 ton per hr. by cold melting will give 4 to 5 tons of duplexed metal in the same time and for about the same consumption of power. Incidentally, it adds only about 5s. to 10s. per ton to the cost of cupola metal. On the other hand, it cannot utilise cheap light scrap, such as borings, to the same extent as the cold-melting process, which, of course, can take charges consisting wholly of borings and turnings and produce satisfactory high-duty castings.

Comparison of Respective Types of Furnace

The hearth-type or direct-arc-type furnace is better suited to the handling of large charges and high outputs, especially when the material consists of heavy scrap. The rocking-arc furnace is limited to a certain extent by the undesirability of a large single-phase load, which will not be countenanced by many power-supply authorities. It is therefore restricted to some extent in size, especially in this country. It is eminently suitable for iron melting, and is in use in this country in sizes up to ½ ton per hr. For continuous cold melting and for continuous duplexing the 3-phase hearth type of furnace is more amenable. The rapid stirring or rocking action of the Detroit furnace is very advantageous for charges high in alloying elements. In both types of plant the atmosphere can be maintained non-oxidising, and melting losses are low in both instances. As regards efficiency, there is little to choose between the respective types. The refractory costs are rather lower in the 'Lectromelt or similar plant, and the refractories are more accessible for patching whilst hot. The rocking-arc furnace is particularly useful in the case of a small jobbing foundry or repair shop where non-ferrous metals as well as irons are cast. The same furnace unit can be used for both melting operations by the use of two separate shells or furnace bodies, which can readily be interchanged.

Operating Data

The consumption of power for melting and superheating cast iron generally varies from 550 to 650 kw.-hrs. per ton, depending to some extent on the size of furnace, pouring temperature and other factors. Refractory life in the Detroit furnace varies from 200 to 300 heats or more, depending upon conditions. In certain cases effective patching is done each week-end, and more often if required, and the same lining has withstood three years' service. In this case the maintenance of the lining works out at approximately 4s. per ton. In the 'Lectromelt furnace and similar direct-arc furnaces the hearth life is practically indefinite if proper fettling is carried out. The roof and side walls generally stand up to 400 to 800 melts. Refractory costs are generally of the order of 2s. to 3s. per ton of metal cast. Metal losses range from 1 to 4 per cent., the higher figure being when all borings are melted.

Now there arises the all-important factor of comparative costs. The cupola, in common with

all shaft furnaces, is an efficient appliance, and, comparing fuel costs in the cupola with electricity costs, the latter is about 10 times the cost of coke. It should be remembered that this is only one of a number of items which make up the cost of iron in the ladle. After a summation of all the melting-cost items, electric-furnace melting is still well over twice as expensive as cupola operation. The only factor which has been omitted is the cost of raw materials, and it is here that the electric furnace can often show such a saving as to make the total cost of iron so produced comparable with, and sometimes less than, cupola metal. In Table I is set out a comparison of costs on this basis.

TABLE I.—*Comparison of Melting Costs.*

Cupola.	£	s.	d.	Electric furnace (3 tons capacity).	£	s.	d.
Blast and power, labour, refractories, maintenance	0	10	0	Electricity, 600 units at 0.5d.	1	5	0
2 cwts. coke	0	2	0	Labour	0	4	0
Flux	0	0	6	Electrodes, 8 lbs. at 10d.	0	6	8
7 per cent. metal loss	0	6	4	3 per cent. metal loss	0	2	6
Depreciation	0	1	6	Refractories	0	4	0
				Depreciation and amortisation	0	5	0
Melting cost	1	0	4	Melting cost	2	7	2
Cupola charge—				*Typical electric furnace charge—*			
10 cwts. foundry scrap	1	10	0	10 cwts. C.I. borings	0	15	0
10 cwts. pig (low P. & S.)	1	18	0	5 cwts. light steel scrap	0	10	0
				5 cwts. foundry scrap	0	15	0
Metal cost	3	8	0	Metal cost	2	0	0
Total cost per ton of iron	4	8	4	Total cost per ton	4	7	2

The electric furnace can utilise with an exceptionally high recovery such materials as borings, punchings, sheet clippings or turnings which have usually a very low market value. Actually, many thousands of heats have been made of all iron borings, and material has been cast showing superior tensile properties to those obtainable by melting high-grade or refined pig-irons. It is usual, however, to add a proportion of foundry scrap to the mix, as well as some steel scrap, if this be available at a comparatively low price. For many low-silicon white irons, for malleabilising or otherwise heat-treating, it is often current practice to make up the charge entirely of light steel scrap, ferro-silicon and crushed coke as a carburiser. Owing to the high temperature and the reducing atmosphere, it is possible to get a carbon recovery of from 65 to 75 per cent. even in high-silicon mixes.

As regards duplexing, these costs must not be added to the cost of cupola metal, since certain savings can often be effected; for instance, a lower-grade pig-iron can be used in the cupola, which can be offset by the addition of steel scrap during duplexing. Some costs are set out below:—

	s.	d.
Power to superheat 200 deg. C.—		
Melting 3 cwts. of steel scrap—170 units at 0.5d.	7	1
Electrodes	1	6
Labour	1	6
Refractories	1	3
Alloys	1	0
Depreciation	1	0
	13	4
Deductions:—		
Difference between cost of cupola metal and 3 cwts. of steel scrap	6	0
Allowance for cheaper pig in cupola	2	0
	8	0

Net cost of duplexing: 5s. 4d. per ton.

Advantages of Electric Melting

In the first place it is possible to impart a controlled degree of superheat to obtain a refined graphite structure. It is not proposed to discuss the effects of superheat and the causes of graphite refinement, but it will be sufficient to say that it is extremely beneficial in producing increased tensile properties, the improvement for a 200 deg. C. superheat from, say, 1,400 to 1,600 deg. C. being from 35 to 65 per cent. in ultimate stress depending upon the type of iron. The simultaneous separation of graphite from a large number of nuclei also favours regularity of properties such as hardness throughout large sections. Superheat also permits of the casting of thin intricate sections without having recourse to increasing the phosphorus content. A further advantage of superheat will be discussed in relation to malleable and other white irons.

The effect of gas and inclusions in cast iron is at present a relatively unknown factor, but it is a fair assumption in the present state of knowledge to assert that some of the improvements and properties, which have been obtained by electric melting, and which are not attributable to any other factor, may be brought about by the absence of gas.

Control of pouring temperature is always a desirable feature. In the electric furnace the heat input is variable, but is a known factor, and under standardised melting practice it is possible to determine the temperature of the metal in the furnace by the number of units of electricity which have been liberated. Many furnaces are fitted with indicating kilowatt-hour meters with a resetting dial, so that the operator can put the same number of units into the charge and be certain that the pouring temperature will be repeated within narrow limits on duplicate charges.

Control of composition is one of the accompaniments of the ideal conditions of melting which persist in the electric furnace. One may be certain that whatever is charged into the furnace makes its appearance in the final analyses and the change in composition or, in other words, the loss of alloys, is extremely small, due to the normally reducing atmosphere in the furnace. Tests made have shown that this can be maintained at about 40 per cent. CO, the balance being chiefly nitrogen. This makes possible the duplication of analyses and results which becomes a matter of routine. T. R. Twigger recently reported in a Paper that a charge of iron containing 3.38 C, 2.03 Si, after being left in a Birlec-Detroit rocking-arc furnace for one hour showed that the carbon had only fallen to 3.36 and the silicon to 1.95. The following are typical analyses of many hundreds of charges of iron borings before and after melting.

	T.C.	Si.	Mn.	P.	S.	Transverse strength. Lbs.	Pouring temp. deg. C.
Borings charged	3.24	2.70	0.59	0.18	0.11	—	—
Metal poured	3.15	2.60	0.57	0.18	0.10	4,100	1,550

It is the general experience of electric-furnace users that charges can be so calculated that over prolonged periods the variation in carbon or silicon content rarely exceeds 0.05 per cent. It is also found that when melting compositions such as Ni-resist and Ni-hard that there is no change in nickel, chromium and copper content, even after the repeated remelting of sprues and gates.

This then brings the subject to the effective use of alloys. Ladle additions are admittedly unsatisfactory. The mixing is here done at the lowest temperature, segregation is frequent, and often the chilling effect is such as to lose the benefit of the alloys. In the electric furnace the alloys can often be added at the beginning of the heat so that complete assimilation is obtained and the furnace can be rocked to aid mixing whilst there is a minimum of loss. There is no sulphur pick-up as in the cupola, and if a small sulphur or phosphorus reduction is required this can be effected by dilution with steel scrap. In certain rare cases, however, treatment with a lime-fluor-spar slag in a basic lining has been practised. Other benefits of electric melting will be touched upon when specific applications are dealt with.

Application in the Jobbing Foundry

The majority of foundries in this country would probably come under the classification of jobbing foundries as there are only a few which are laid out for the mass production of castings, and these latter are mainly employed for light automobile castings and engine parts. The electric furnace holds out attractive possibilities to the jobbing founder who is called upon to cast a variety of compositions, especially if these are to strict specifications as regards analysis and physical properties. With a cupola it is more often than not necessary to defer production until a sufficient tonnage of a specified grade of iron has accumulated to make its operation economical, as it is extremely difficult to keep charges separate in the cupola even though a heavy layer of coke be interposed. Moreover, the intermittent operation of the cupola often entails a certain amount of pigging owing to the first tappings being too cold.

In the case of the electric furnace, it is possible to start up a melt (in a cold furnace) and have a heat of iron ready for pouring in approximately 2 hrs. in a small rapid-melting electric furnace. From then on, heats can be poured at hourly intervals, whilst the charges can, if necessary, be all of differing compositions. The electric furnace is undoubtedly the most rapid melting appliance available to the foundryman. Furnaces up to 1 ton in capacity are capable of melting their charge in 1 hr., whilst larger units of 4 to 5 tons take only 1½ to 2 hrs., depending upon the degree of superheat required. This naturally brings advantages, such as a small moulding space and a regular flow of metal at short intervals.

The furnace can be worked quite efficiently even if operated intermittently and not to full capacity. For instance, a normal ½-ton-per-hr. furnace can be employed for melting 200-lb. charges, whilst, if required, a casting of up to 1 ton in weight can be poured. In periods of abnormal production, when irons are required which have to conform to the strict compositional and strength requirements, the same furnace can be used to treat molten metal from the cupola. The metal is adjusted in composition, alloying additions or steel scrap added, and it is superheated to the desired degree in the electric furnace. This furnace, when used in this manner, would have an output of 2 to 3 tons per hr. It will, therefore, be seen that one single unit is sufficiently flexible to meet, economically, with a demand for high-duty irons ranging from 3 to 25 tons per 10-hr. day.

It will be realised that the features outlined above are extremely advantageous from the point of view of offering rapid deliveries. This, as might be expected, is a great benefit in

American foundries, where it is stated castings can be despatched if required in about 12 hrs. from receipt of patterns.

Electric Furnace in the Mass-Production Foundry

The advantages of control of temperature, composition and furnace atmosphere apply equally to the large production foundry. If batch-type melting plant is used, tests can be duplicated with extreme precision, whilst continuous melting and duplexing have the advantage of a large reserve and a constant supply of metal at very short intervals. Such parts as cylinder blocks, cylinder heads, manifolds, camshafts and crankshafts are regularly being produced by these methods. For cylinder-block castings it has been found that in the electric furnace it is possible to hold the hardness figure over a period of a month between 203 and 216 Brinell. Previously, in the cupola the variation obtained was between 165 and 205 over the same period. The minimisation of rejected castings alone is sufficient to outweigh any difference in the cost of production. On the other hand, all the machine-shop scrap, such as borings, can be utilised, materially reducing the cost of raw materials.

Electric Furnace for Malleable Production

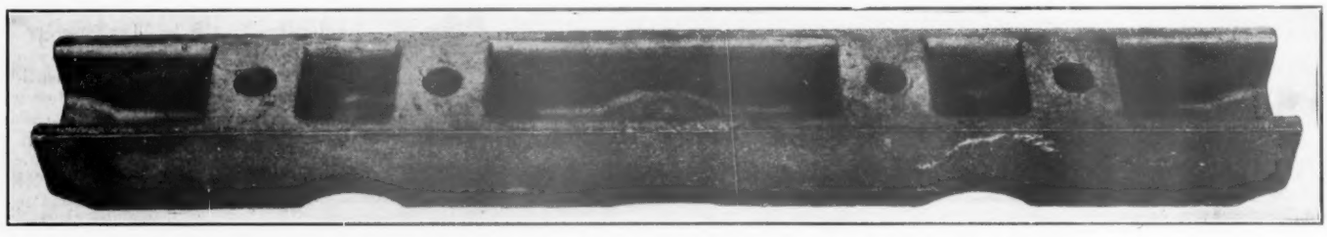
The electric furnace is not a newcomer to this field, and was first used in what was known as the Kranz Triplex process. This entailed the melting of pig in a cupola, removing carbon, manganese and silicon in an acid converter, whilst a basic arc furnace served to dephosphorise, remove sulphur and deoxidise. This process is not now in use, and has been supplanted by straight melting or duplexing. Dealing with malleable irons, these remarks will only apply to black-heart practice. Taking an iron containing 2.5 to 2.8 per cent. carbon and 1.1 to 1.2 per cent. silicon, the normal total annealing time for this material was previously 140 hrs. By superheating this iron to 1,580 deg. C., it is possible to break down the massive carbide in 20 hrs. at 950 deg. C., whilst 26 hrs. at 715 deg. C. is sufficient to convert the pearlite into temper carbon and ferrite. With the modern continuous annealing furnace, it is possible to complete the whole annealing cycle in slightly over 50 hrs. The savings effected in fuel costs, boxes (if used) and the ability to effect quick deliveries have been important factors in the adoption of this improved method of melting malleable iron. The nodules of temper carbon are more evenly distributed and are finer grained. The physical properties generally range from 21 to 23 tons per sq. in. in ultimate stress and 15 to 18 per cent. elongation.

Not content with this improvement over previous practice, attempts were directed to shortening still further the processing time. It was found that, by raising the silicon to 1.4 to 1.7 per cent., slightly reducing the carbon to 2.2 to 2.5 per cent., at the same time superheating the iron, it is possible to break down the primary carbide at a greatly increased rate. The effect of superheat on this material is to prevent the separation of primary graphite as the molten metal cools, and it ensures the production of a white iron even with a moderately-high silicon. Several foundries are now using this process to produce completely malleablised iron with an annealing cycle as low as 20 hrs. The typical time cycle for charges up to 5 tons of material, as quoted by Morken, would be as follows:—Heat to 950 deg. C. in 3 hrs.; hold at 950 deg. C. for 4 hrs., and cool to 670 deg. C. in 14 hrs. The following are the properties of this material:—Tensile strength, 26.8 tons per sq. in.; elongation on 2 in., 15 per cent.; Brinell hardness, 150. The structure of this material is essentially finely-divided temper carbon set in a ferrite matrix.

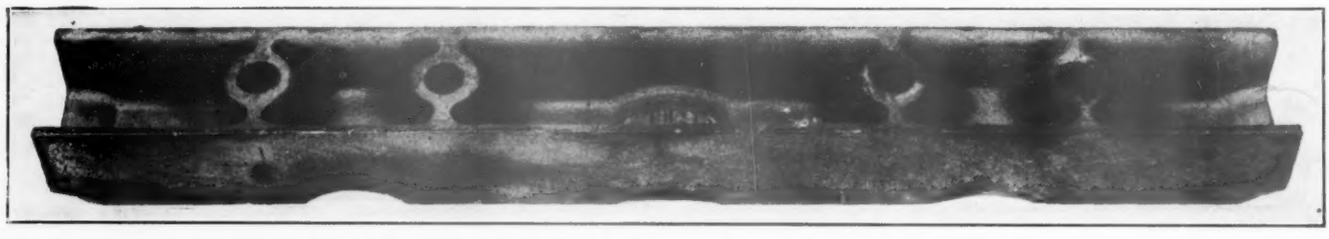
A 4-hr. soak at 950 deg. C. is sufficient to break down completely the massive cementite. If higher strengths are required the casting can be allowed to cool rapidly to 700 deg. C., at which temperature they are maintained for a period of 3 to 6 hrs., depending upon the section of casting and properties desired. This treatment merely serves to break down partially the eutectoid into spheroidal cementite and ferrite. Another method of achieving the same results is to cool slowly from 760 to 650 (at about 30 deg. C. per hr.). Alternatively, if the section is not complicated, oil quenching from 810 deg. C. may be employed, followed by reheating to 700 deg. C. for a period of 1 to 4 hrs., depending upon the properties desired. The slowly-cooled material or the material held for 4 to 6 hrs. at 700 to 715 deg. C. will have a strength of 22 to 24 tons per sq. in. with an elongation of 10 to 12 per cent., whilst the material quenched and reheated for 1 to 2 hrs. at 700 deg. C. will show a tensile figure of 45 to 50 tons per sq. in. and an elongation of 3 to 6 per cent. The composition cited above refers to approximately ½-in. section material. The castings which have been quenched and tempered for a short period have a partially spheroidised sorbitic structure with small particles of temper carbon. The feature of these short-cycle irons is their high elastic limit, which averages 75 per cent. of the ultimate stress. These properties are undoubtedly remarkable considering that the total treatment only occupies from 7 to 10 hrs. These low-carbon, white irons generally all made synthetically from steel scrap, coke and high-silicon pig or ferro-silicon and are comparatively cheap to produce. They are being used for a variety of purposes, chiefly replacing steel for wear-resisting parts and parts requiring a high elastic limit.

Then there are the martensitic irons which may vary in composition, a typical one being 3.1 per cent. carbon, 2.10 per cent. silicon, 0.5 per cent. chromium and 1.2 per cent. nickel. This is quenched from 820 deg. C. and tempered at 250 to 500 deg. C., depending upon the properties desired. The hardness may range from 375 to 520 Brinell, depending upon the tempering temperature.

The application of these high-strength heat-treated irons as produced in the electric furnace include fuel-injection pump parts, in which wear resistance is required, wear-resisting rollers, cams, compressor parts, moulds for bricks and plastics, jigs, bushings, transmission parts for motor trucks, coal-pulveriser parts, and so on.



Old-Pattern Casting in Cupola Iron. Weight 31½ lbs. Price 6s. 11d. each.



New-Pattern Casting in Electric Iron. Weight 21½ lbs. Price 5s. 5d. each.

FIG. 4.—BAFFLE SUPPORT CASTING FOR BOILERS. AN EXAMPLE OF THE APPLICATION OF ELECTRIC FURNACE IRON ILLUSTRATING REDUCTION IN WEIGHT AND CHEAPENING OF CASTING.

General Applications of Electric Furnace Iron

Turning to the more general uses of electric-furnace irons there are such parts as piston rings, which have to be free from hard spots, brake drums, glass-bottle moulds which must be heat-resistant and free from surface defects, cylinder liners, chilled-face valve tappets, manifolds, camshafts, papermaking rolls which are to be free from surface imperfections, gears, clutch plates, and flywheels. The electric furnace is also used very widely for the production of high-alloy irons, such as Ni-Resist, Ni-Hard, high-chromium heat-resisting compositions, high-silicon irons for corrosion resistance, and high-manganese irons for non-magnetic castings. On the other hand, it is being used for such every-day castings as manhole covers. In many cases the reduction in the weight of the casting made possible by the increased strength of the electric-furnace product has made the latter cheaper to produce.

It will, therefore, be seen that, whereas some ten years ago cast iron had to fight increasing competition from steel, to-day it is replacing its neighbour for a growing number of purposes. It shows greater wear resistance, is easier to machine than steel having equivalent physical

characteristics, and is capable of taking the higher surface finish. It possesses a better bearing surface, which is less likely to seize up due to its self-lubricating properties. Moreover, it is easier to produce and cheaper than steel castings or forgings.

Application of the Electric Furnace in the Brass Foundry

The only type of electric furnace which has found any widespread application in the brassfoundry is the Detroit rocking-arc furnace. Although some installations have recently been made in this country, it is in America that the majority of installations are in operation.

It meets with most non-ferrous foundry requirements. Rapidity of melting—it will melt brass in 20 to 25 min. per charge—is one of its main features, whilst the metal is continuously rocked, ensuring a minimum of segregation, which is specially important when melting brasses containing lead. The effect of this stirring movement is revealed by analysis of the first and last castings poured from a heat containing 12 per cent. lead. The maximum variation in lead content in this case rarely exceeds 0.15 per cent. Rocking of the furnace also ensures that the refractory is continuously washed by molten metal, thus prolonging its life and protecting against local overheating of the charge. The atmosphere is normally reducing, which prevents oxidation, and since the metal is melted out of contact with furnace atmospheres containing hydrogen, water vapour and SO_2, there is less tendency to the development of porosity. It has been established almost unassailably that the deleterious influences which produce unsoundness are the above-mentioned gases. Temperature control is closely regulated by adjustment of the power input to the metal, and in this way it is possible to determine temperature to within 20 deg. C. Owing to the fact that the correct pouring temperature for foundry brasses lies very near to the point at which free volatilisation of zinc takes place, it is essential to control the temperature to within very narrow limits if zinc loss is to be minimised. In the Detroit rocking-arc furnace the loss experienced on high-zinc charges ranges from 1.2 to 2 per cent., depending upon the composition, the casting temperature, and the nature of the charge melted. On low-zinc alloys containing approximately 5 to 15 per cent. of zinc, the loss is normally 0.5 to 1.2 per cent.

Melting costs compare favourably with crucible practice when all factors, including metal loss, are brought into consideration. As a rule, the total melting cost in the electric furnace is of the order of 30s. per ton, as against 40s. to 45s. per ton for crucible operation. It is, of course, cheaper to melt brass electrically than cast iron.

In the first place, the power consumed is approximately one-half that required for cast iron, averaging 280 to 300 units per ton. Refractory costs, owing to the lower operating temperature, are approximately 1s. 6d. per ton (the lining generally averages 2,000 heats with effective patching), whilst the output on brass is approximately double that obtained on cast iron in a similar furnace.

The chief applications of the electric furnace in the brassfoundry are for leaded bearing alloys for bushes, etc., brass sanitary fittings which are subsequently plated and have to be free from pinholing, pressure valve, bronze gears, pump parts, lubricator bodies, and miscellaneous foundry castings. It has been found that the reduction of rejected castings due to porosity has resulted in untold economies, apart from any direct saving in melting costs.

Conclusions

An attempt has been made to review in a very broad manner the place which the electric furnace does, and could, occupy in the cast-iron and brass foundry, and has indicated its possibilities both economically and from the point of view of the quality of material produced. There may not at present be a widespread demand for some of the products which have been described, but it rests with the producer of castings to create this market, which, once firmly established, will undoubtedly grow, and it is certain that the electric furnace will play an important part in this expanding field of high-strength irons and high-quality non-ferrous castings.

West Yorkshire Foundrymen's Annual Dinner

The annual dinner and dance of the West Riding of Yorkshire Branch of the Institute of British Foundrymen took place recently at the Great Northern Victoria Hotel, Bradford. Mr. F. K. Neath, B.Sc., Chairman of the Branch, presided over a large assembly, and the chief guests were the Lord Mayor of Bradford (Alderman Jonas Pearson—himself a member of the foundry industry) and Mr. J. E. Hurst, President of the Institute, accompanied by Mrs. Hurst.

The Guests

The CHAIRMAN (Mr. Neath), giving a toast to "Our Visitors," said it was a great privilege to the West Riding Branch to have as their guests both the President of the Institute, who had an international reputation as a metallurgist, and the Lord Mayor of Bradford, who was himself a foundryman. The reputation of Mr. Hurst in metallurgical matters needed no emphasis to anybody associated with the foundry industry; they all held him in the highest esteem as a President and as a man, and had the utmost admiration for his work in the encouragement of metallurgical research and his own personal activity in new developments in cast iron. Alderman Pearson, Mr. Neath believed, was probably the first foundryman to be Lord Mayor in his own city of Bradford, and certainly was the first foundryman Lord Mayor to whom the Branch had ever had the honour of offering their hospitality.

Ramorum Defensor

Turning again to the Institute's esteemed President, Mr. Hurst (said Mr. Neath) was a man whose work on the Council they had every reason to value, not only in its national and wider sense but because of the close interest he took in the walfare of the Institute's branches. On English coins, remarked the speaker, was the inscription *Fidei defensor*—Defender of the Faith. He would suggest the members of the Institute of British Foundrymen, and especially those who took an active part in branch work, might suitably apply to Mr. Hurst the motto *Ramorum defensor*, or Defender of the Branches.

Apprenticeship Recruitment

The LORD MAYOR OF BRADFORD (Alderman Jonas Pearson), responding to the toast, said he was proud to be an ironfounder and to be associated with the industry represented there that evening. It was up to members of the industry to give their organisation more of their personal interest and to help in the fine work it was doing. It was up to them also to help in making their industry more attractive to boys of character, intellect and enthusiasm. Unless something was done in this direction there would be a danger of a serious shortage of good men in coming years to produce the first-class castings modern engineering demanded. The call for technical education in the production of skilled moulders and other foundry workers could not be too strongly stressed. His Lordship paid tribute to the work of the Bradford Technical College and similar instructional institutions which had engineering and foundry classes. They were glad to have among their guests that evening Mr. H. Richardson, Principal of the Bradford College. The staff of the Bradford College, it was gratifying to note, were not discouraged in their own good work by the persistent difficulty which seemed to obtain in getting young men of the foundry industry to come forward in substantial numbers to take advantage of the tuitional advantages provided for their good. His Lordship, in conclusion, wished the Institute as a whole and the West Riding Branch in particular every success.

Voluntary Effort

The PRESIDENT of the Institute (Mr. J. E. Hurst), proposing a toast to the West Riding Branch, said that as an Institute, and one of the leading metallurgical organisations in the world, they had to rely a good deal on voluntary work, and he did not think that it was quite sufficiently understood and appreciated by the whole of the members. There were national and branch officers, research and technical committees and many other activities, all of which were essential if the Institute was to maintain its place in the growth and development of foundry metallurgy. The extent of that development, particularly in the past ten years, had astonished metallurgists. Unless the Institute was in a position to keep pace with such development and that which was still to come, it would find itself in difficulty and would put into difficulty the industry which it was its privilege and function to represent. It behoved, therefore, every single member to give all possible thought and attention to the future development of the work, and particularly to come forward to support the voluntary work required and which, in many cases, was being so magnificently undertaken. Tribute also was due to the good work of the staff. Mr. Makemson, the Secretary, put the West Yorkshire Branch amongst the premier Branches of the Institute, and, in common with the officers, had a very high admiration for the work done in and by this Branch. The presence of the Lord Mayor of Bradford was not only a proof of public recognition of the importance of the Branch and the industry for which it stood in this area, but was a special pleasure when they knew that his Lordship was also a member of this important industry. It was a tribute to the worth of Yorkshire foundrymen to know that one of them had risen to the high office of Chief Magistrate of his city. In the West Riding Branch there were men who were doing great work for the foundry industry, both within and beyond their own Branch. The Branch-President (Mr. Neath) was one of the most-valued voluntary officers as chairman of the Literary and Awards Committee of the Institute—a most important and responsible office associated with the improvement and development technical literature—and as Convenor of the Technical Sub-Committee dealing with Melting Furnaces. The hon. secretary (Mr. Wise) was one of the most active men in the Institute. He stood out pre-eminent amongst secretaries and rendered valuable service on the Council, and he hoped the Branch would long retain his services. Another highly-esteemed member was Mr. A. S. Worcester, one of the Past-Presidents and an enthusiastic worker on the Cast Iron Sub-Committee of the Institute.

A West Riding Conference?

MR. G. HALL, Senior Vice-President of the West Yorkshire Branch, responding to the toast, said he had been associated with three Branches of the Institute, and was glad to feel that he had been made welcome at all of them. The Branch had never yet had a President of the Institute from the ranks of the West Riding Branch. That was, he hoped, a privilege still to come; but in the meantime there was a Past-

(*Concluded on page* 179.)

Modern Casting Manufacture

SILT IN SAND DISCUSSED

The discussion on Mr. A. Phillips' Paper, "Some Points in the Modern Production of Castings,"* read to the Burnley Section of the Institute of British Foundrymen recently, was opened by the Chairman of the Section, MR. LAWSON WHARTON, who said he was sure they had all heard Mr. Phillips give a very interesting Paper, on what he would call a combination of technical and practical knowledge of the foundry.

Vote of Thanks

MR. ALEC JACKSON, proposed a vote of thanks to the lecturer, and said they had had, as expected, a very fine address on various points of foundry work, well worth coming some distance to listen to. Even if members had a fair amount of practical experience, when it came to such lectures, which took them out of their practice, they felt rather small.

MR. HOGG, seconding, said that although Mr. Phillips was a metallurgist, he had made himself clear to every foundryman present. It had been said sometimes that those men spoke over their heads, but it could not be said that evening.

The vote of thanks was heartily carried.

The Silt Question

MR. J. PELL said that there was one thing the lecturer had omitted to mention. That was the silt in sand bogey. One sent a sample of sand away to be analysed, and it came back with a detrimental report, to say that there was too much silt in it. That was his experience, but at the same time they were producing high-grade castings. He would like to know why the lecturer had not mentioned the matter of silt in sand.

The LECTURER replied that he only just touched upon the subject of sands. He had not explained everything that was in sands and silt. Some people, especially in America, washed the silt out, because they had artificially bonded sands there, and the grains became so broken with constant reheating that they were reduced to a very fine dust. Silt was the useless constituent of sand, but could be removed, similarly to coal and like material, by flotation. For medium-grade castings, however, a silt was not disadvantageous. Nevertheless, it would be detrimental in core sand, where mixed in the round-grained sea sand, since it would collect between the grains, thus reducing its permeability.

Analytical Reports

MR. HOGG said he thought Mr. Pell was really questioning the competence of the analyst. Everybody knew that sometimes, for instance, plumbago was analysed. After the analyst had ascertained the fixed carbon, and one or two minor constituents, such as moisture, he described the residue as ash. He, himself, had blacked a mould with plumbago, which consisted of the ash that had been left after fixed carbon had been removed, and had had perfectly good results, as long as it was not gritty. He did not think that the analyst Mr. Pell had in mind understood the functions of what he was analysing.

More About Silt

The LECTURER said that probably it would be of interest to describe a little bit more about the silt. One of the tests to which sand was submitted was the sedimentation process. They placed an inch of sand in a tube, filled it with water, and violently agitated it. On being left to stand, one would find that all the large grains immediately settled at the bottom, and then the other grains in layers superimposed themselves, whilst the clay matter remained suspended. Finally, there was the uppermost layer, containing a milk-like material in suspension, which was termed a colloid. If some sand core or sea sand that had been used for a long time and had had rough treatment was shaken up in a bottle, it would be found that the large grains were settling down rapidly, while the other material formed stayed in suspension, but finally it settled. There was no bond, but there was a fine, silty material, which remained at the top. That was the silt that they had in sand.

As for Mr. Hogg's reference to plumbago, he certainly agreed with him that, when the fixed carbon had been separated from the ash, there remained material sufficiently highly refractory to be the equal to carbon itself. This question of refractoriness of ash in plumbago was one bound up with the sulphur content.

Speed of Pouring

MR. JONES said, with regard to the speed of pouring metal, 1.55 sq. in. per ton was found to be quite satisfactory for dry moulds, but he would like to know whether it was adequate for steep castings, with ½-in. thickness, ranging from 10 cwts. to 3 tons, as he found that the best speed was about 2.5 sq. in. per ton.

The LECTURER said he should have made some qualification about that. He was meaning castings round about 4 ft. to 6 ft. deep made in dry-sand moulds. He agreed with Mr. Jones that they had to vary their runners in some cases. There were certain castings where they would probably have a ratio of 3 sq. in. per ton of castings, but he mentioned that, when he was talking about castings which were 6 ft. deep and 12 ft. wide. Sometimes it was quite difficult to know what size of runners to use, if one used too much runner area one would not be able to keep the runner full. If one did not put sufficient runner on the metal would not reach to the top of the job. That was why he just gave an illustration of what was about the average to work upon. But, he certainly agreed with Mr. Jones that, for example, in green-sand moulds, one reached as much as 3 sq. in.

Runner Area Ratios

MR. JOHN JACKSON (Lancashire Branch-President) asked if it were wise to enunciate an amount of ratio of runner area for castings. For instance, the lecturer had said that a certain area of runner size for a certain weight of casting varied according to whether the mould was of dry or green sand. He did not think it mattered so much, but asked himself how they would fare with jobs of the description of long channel rails such as were used on spinning frames. Such a job was a rail from 14 ft. to 16 ft. long, to be run at one end, with a wall-section thickness of ¾ in., with mid-feather arms round about ½ in. across. They found there that they had to swill the metal through as large a runner as they dare possibly use—a runner would take the metal without bursting, though, in order to get the metal to the end of the mould, and yet due to what might be termed the filtration shape of the ingate, they did get clean castings with it. He would imagine that these castings were something of the order of 4 cwts. or even less. The runner size would be double the size the lecturer had given for a casting of that weight. Much depended on the nature of the job, and no hard-and-fast rule could be made.

The LECTURER said that it was a question, as he had said before, of previous experience on the particular job, in fixing the runner area. He agreed with Mr. Jackson that the question of runner size was very arbitrary. But he gave a job of the type that one had only once to try out. There were many jobs, indeed hundreds, where they had arranged for runners in some cases up to six sq. in. to a ton, because they were only just little bits of arches. But the reason why he mentioned that was, if they took large castings, anything say round about from 12 to 40 or 50 tons, and they took the runner ratio of what he had said, he did not think they would be very far wrong. On smaller castings he would not talk about runner ratio because one could not definitely say anything, as each casting was a problem in itself.

Mould Drying

MR. F. HARRIS raised the question of drying by means of a mould dryer, as the lecturer had mentioned that the hot gases were passed down the downgates, through the ingates, into the mould, and up to the riser. That was as far as he understood it. Was that sufficient to dry the whole of the mould thoroughly, or did he recommend some other special methods in order to get satisfactory results by placing a special downgate for the gases to pass down, and another for them to pass out of the mould cavity?

The LECTURER said if he had inferred that in his remarks, he was mistaken. A mould after receiving its top part, dryers were installed on the latter. The hot gases entered through openings in the top part, and into the mould cavity, and came out through the end runners of the two gates at both ends. He said that an excellent feature about that type of drying was the passing of hot gases through the runner and the ingates. In the old method as compared with the new, if one used coke fires one sent moisture to the face, and this did not effectually dry the runners. With a large mould such as one for a heavy turbine casing, or a big base tank, with down runners, and one placed a modern dryer on the top of the runner, and operated for a couple of hours, they would be surprised at the results they would get in all the part adjacent to the corner.

A Novel Sand-Drying Process

MR. HARRIS asked whether Mr. Phillips when he was mixing sand, used the sand dry, or not.

The LECTURER said that they used dried sand. They had various methods of drying; one was the utilisation of stoves. Another method incorporated the use of two parallel railway lines, over which ran a roller carrying a series of pig-patterns all over the surface. Men filled in the area in between with sea sand, and after levelling it off, rolled it, and so formed a series of moulds like the ordinary pig bed in blast-furnace practice. Any spare metal made during the course of the day was poured into these moulds, and in doing so dried the sand adjacent, and that was how they dried the sand.

Bury Road Sand

MR. HOGG said he did not think Bury road sand was clearly understood locally. Bury road sand was one of the finest sands, in his opinion, that they had in the country, as far as it went, but it should not be milled.

The LECTURER said he fully agreed with what Mr. Hogg had said. He had been unable to find any sand the equivalent of Bury road sand, either in this country or on the Continent, but there was one thing about Bury road sand, and, as Mr. Hogg said, they destroyed a lot of its characteristics if they milled it. Also Bury road sand was used in making cases adjacent to runners where they got a very hard scouring action of the metal. If one mixed Bury road sand with a handful or bucketful of iron turnings, or iron filings, and used it adjacent to the runners on a heavy casting, one had in this region a facing which would stand any of the scouring action of the passing of probably 50 or 60 tons of metal off that runner point.

* Published in ur issue of January 30, 1936.

Leaves From a Foundryman's Notebook

VIII.—MOULDING TYPICAL SOLEPLATES

By RECORDER

The system of fabricating bedframes for various types of machines, although having advanced considerably during recent years, has not yet quite eliminated the use of cast iron for a large number of bed or soleplates. The following notes deal with the manufacture of these articles by various methods over a period of years. Fig. 1 illustrates a section through one of the simplest forms of bedplate, the plan view of which would be a rectangle. Bedplates of this type are quite often used as the base of various types of small pumping plants.

The traditional way in which this type of casting was produced was from a shell pattern—the replica of the casting—which when moulded and assembled appeared as in Fig. 2, A being the bottom and B the top boxes, while C indicates the "lifters" used to support the hanging pod. Fig. 3 is a section through the assembled mould of the same bedplate made by a different method. At the time this method was adopted there was a shortage of skilled moulders, and a moulding machine being a part of the equipment available

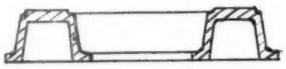


FIG. 1.

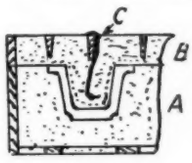


FIG. 2.

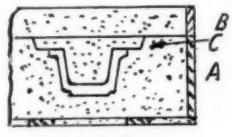


FIG. 3.

FIG. 4.

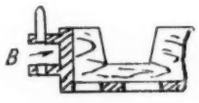


FIG. 4A.

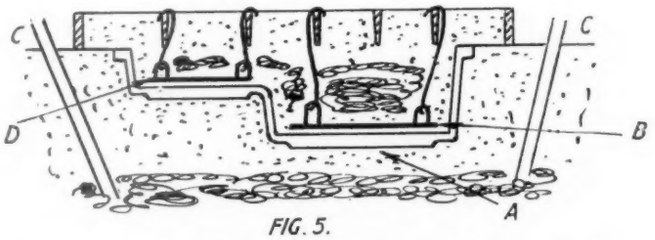


FIG. 5.

FIG. 6.

and sea-sand cores being comparatively easy to make by semi-skilled labour, the arrangement illustrated was evolved. A and B in Fig. 3 are again respectively the top and bottom boxes, while C in this case is a coreprint.

A solid pattern having been made, it was placed on this coreprint, which overhung the pattern. It was a simple job ramming the bottom mould on the pneumatic jarring machine and assembling the sea-sand cores, which were made in sections for the convenience of handling; a plain top box completed the mould. The next step in the evolution of a still simpler method is shown in Figs. 4 and 4A, which illustrate a portion of the pattern equipment which was used on the machine to make both top and bottom moulds and thus eliminate the necessity for the cores shown in Fig. 3.

The pattern for the bottom half was a solid pattern, Fig. 4, as used on the previous method without the coreprint. This was accurately located on the machine table and a mould rammed up. The top was made in a strong cast-iron box which fitted the machine pins accurately, Fig. 4A, B. This was filled with wood to form the inside of the required bedplate. The top half corebox—for such in a way it was—being placed on the machine table, a top box was located by the pin holes and rammed up and lifted off in the usual way. This was then assembled on the bottom half mould, a section of the completed mould having the same appearance as in Fig. 2. Of course, it will be understood that the above method was only adopted for beds which were required in reasonable quantities fairly frequently.

Another type of bedplate is illustrated by a section through its assembled mould, in Fig. 5. This is for an engine and electric dynamo and is narrow compared to its length. The diagram shows this bed moulded in the foundry floor, a procedure not to be encouraged unless definitely necessary because of the lack of a bottom box to accommodate it. If a box were used, the turn-over method of moulding would be employed, but in the case illustrated bedding-in has been adopted. The pattern is a shell pattern, and after bedding-in the bottom the top is rammed in place. The traditional method of producing work of this nature in the foundry floor was to dig a pit somewhat larger than the required casting and about a foot deeper.

In this pit there was then placed a layer of ashes from 4 to 6 in. deep, this being connected to the atmosphere by a number of vent pipes, as at C, Fig. 5. Straw was then laid over the ashes to prevent the penetration of the sand, which was thrown in from 6 to 8 in. deep. The pattern was then placed in position and levelled up and, if thought necessary, cambered. This was done by having three pieces of wood, two exactly 2 in. sq. and the other $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$—or whatever the determined amount of the camber be—extra. The two pieces the same size were then placed one at each end and a piece of string pulled tightly over them; the middle of the pattern was then pressed down until the third piece passed between the string and the pattern easily. The pattern was then weighted in position and the bottom rammed.

The joint being finished a start was made on the top, a layer of sand was laid over the face of the pattern and a grid for carrying the pod placed in position (B, D, Fig. 5). Ashes were then filled in the interior of the pods—as for a core—to assist in venting and avoid scabbing on the large top surface. The top box was then placed on and provision made for its correct location on assembly after drying. The grids B, D were then connected to the top box by hooks and secured in position, and the top box lifted off. The pattern being withdrawn the mould was finished off, the face A being vented down to the ashes, the top stoved and lamps placed in the bottom. The writer has seen bedplates such as the above cast without the cinder bed and bottom venting as described, it being thought that the cinder bed was not necessary and even might be a disadvantage, in that moisture, which collects there during drying, is drawn back again just before casting, when the top is put down and causes the mould to be steamy. The elimination of the cinder bed makes a considerable saving in the time taken to produce this type of casting in the foundry floor.

Fig. 6 is a part-section of a portion of a soleplate for an oil engine, and, as can be seen, a shell pattern is not applicable in this case. A solid pattern and a set of coreboxes would take a considerable time in the patternshop, and as the number required would only be solitary ones spread over a considerable period, just a solid pattern was made. The core was made in a "nest" or sand corebox. A mould being made on the pneumatic machine, it was thicknessed. This was then dried and lined with paper, and the core made in it on a grid. On being dried it was taken out, blackened and placed in the previously-prepared mould on studs.

West Yorkshire Foundrymen's Annual Dinner

(*Concluded from page* 177.)

President of the Institute, Mr. Stobie, now living in the area, and they had the pleasure of his company and views at some of their meetings. The West Riding Branch had every reason to be proud of its officers and its past-officers, and it was a pleasure to note the presence at the dinner of several Past-Presidents—Mr. A. W. Walker, Mr. R. D. Welford, Mr. A. S. Worcester, Mr. W. G. Thornton and Mr. W. Parker—men who, with other past-officers, were consistently helping and encouraging the current year's President and Council in their efforts for the good of the Branch. He also made felicitous remarks about Mr. S. W. Wise, the local secretary.

In conclusion, Mr. Hall said it was with very real regret that he had to mention that, although he was the Senior Vice-President of the Branch and presumably would, in the normal course of events, be the next President, events had occurred which meant that that was not likely to happen. He had had three and a-half very happy years with the Branch, but within the next few weeks he would be leaving the district for another area. He was not, of course, leaving the Institute, and he would cherish very happy memories of his days with the West Yorkshire Branch.

This brought the speeches of the evening to a close, but before the gathering broke up for dancing, on the motion of the chairman, a hearty toast—with wishes for good fortune and happiness—was drunk to Mr. and Mrs. Hall, who were shortly to leave them.

Transformation Points of Iron

Measurements of the mean specific heat of pure iron between 70 and 700 deg. when plotted graphically reveal the existence of six reversible discontinuities at 112, 198, 292, 388, 487 and 591 deg., according to G. NAESER in Report No. 285 of the Mitteilungen aus dem Kaiser-Wilhelm-Institut für Eisenforschung zu Düsseldorf. These discontinuities represent transformation points and the temperature intervals between them, as well as the heats evolved at the various points, appear to follow simple relationships.

Oxygen in Cast Iron and Steel

MR. P. B. HENSHAW, director of Kayser, Ellison & Company, gave an address to the Sheffield Branch of the Institute of British Foundrymen, over which Mr. A. Whiteley presided. The following is a synopsis of Mr. Henshaw's Paper.

It was suggested that the time-honoured property of "body" in steel was in all probability concerned with the effect of oxygen, and, considering their method of manufacture, it was not surprising that oxygen should be present in ferrous metals. The amount of oxygen present in pig-iron and steels was given in detail, and it was also pointed out that pure iron at its melting point will absorb 0.21 per cent. oxygen and that the solid solubility was approximately 0.05 per cent. The melting point of ferrous oxide was then discussed, together with its diffusibility in iron.

It was mentioned that the amount of oxygen in pig-iron, and also steel, did not alone account for the properties they possessed. To support this statement, comparisons were made with various pig-irons containing differing amounts of oxygen, but otherwise of similar compositions, and it was found that the physical properties were not directly dependent on the oxygen contents. The oxygen contents of typical steels made by various processes were given, and it was shown that, as a class, the electrically-made steels (in the arc furnace) were lower in oxygen than those made by other processes. The effect of oxygen on pure iron was discussed at some length, more especially in regard to the physical properties and the tendency of oxygen to produce grain growth.

The next section of the address consisted in an examination of the means of removing oxygen from molten steel and cast iron; all the usual means of deoxidation were examined and the advantages and disadvantages of the various deoxidisers in common use were discussed. It was emphasised that even under the best conditions deoxidisers leave behind in the steel or iron some of their oxides, which may prove to be serious inclusions.

Finally, it was shown that prevention of oxidation, as far as practicable, was advisable, and was well worth the trouble necessary. Methods of achieving this were suggested, and the use of manganese in some appropriate form was emphasised.

DISCUSSION

An interesting discussion followed, which was opened by MR. T. R. WALKER, who said he could endorse all that Mr. Henshaw had said regarding the importance of carrying manganese through the melt, especially in making electric steel. If they allowed the manganese to reach as low as 0.05 per cent., they might easily have trouble with oxides, and the steel could only be corrected after hours of hard work. Even then it was very doubtful whether they could ever restore the steel to its former condition. It was much better to avoid oxidation in the first place than to try to remedy the trouble afterwards. He was greatly interested in what Mr. Henshaw had said about small and large particles of non-metallic matter in steel ingots. He agreed with what Mr. Henshaw had said about the movement of these particles, which rose in the liquid metal at a rate varying approximately as the inverse square of the radius of the particle. One would expect, therefore, that, as soon as the ingot mould was filled, all these particles would start moving upwards at different rates, so that when the metal was solid the greater proportion of the non-metallic inclusions, including most of the big particles, would be found near the top of the ingot, whilst the bottom portion would contain inclusions of a smaller size. Actually, this was not the case. They found, on examination, that the non-metallic inclusions were present to a much greater extent in the bottom part of the ingot than near the top. Explanations had been offered for this phenomenon, but metallurgists were not yet unanimous in their agreement regarding its cause.

Form of Oxygen

With regard to the effect of oxides and of the amount of oxygen present in steel, he was not quite certain whether Mr. Henshaw claimed that when he added deoxidising agents he reduced the amount of these oxides and oxygen, or whether he merely meant to convey that he changed the form in which these occurred and put in something else which was not quite so harmful. Mr. Henshaw referred to aluminium, and in connection with oxygen said that a high oxygen content was associated with large crystal size, and conversely that a low oxygen content implied small crystals in the steel. Aluminium had recently been used very extensively in the way of producing steel of a definite grain size. The aluminium was probably effective in this connection by promoting crystallisation owing to the formation of a considerable number of sub-microscopic nuclei which acted as centres for crystal growth, and not by removing oxygen as such.

Time Factor and Sulphur Condition

There was one point upon which he would like Mr. Henshaw to offer some explanation. In a carbon steel containing, for example, 0.05 per cent. sulphur, they could determine the sulphur volumetrically by dissolving the steel in hydrochloric acid and absorbing the hydrogen sulphide evolved in a zinc or cadmium solution. If the drillings were freshly prepared, this method gave results agreeing very well with those obtained by the gravimetric process, but if the steel drillings were kept in stock for, say, a year, and a volumetric determination of sulphur carried out after that time, they found that the result given by the evolution method was much less than it should be; sometimes only half the sulphur in the steel was evolved as sulphide. If, however, the drillings were then annealed in a non-oxidising atmosphere, the result of the evolution of sulphur determination would rise practically to its former value.

Oxygen and Quality

MR. P. GREEN said that oxygen apparently increased grain size, increased corrosion, and was generally very bad, especially in steel. On the other hand, Mr. Henshaw, in his comparison between a coke-produced iron and a charcoal iron, had endeavoured to point out to the foundry world that oxygen became advantageous. Charcoal iron, having a higher quantity of oxygen, was the better of the two irons. When one considered the constituents of cast iron and the effect of rate of cooling upon the amount of combined carbon present, it was very difficult to say exactly how that oxygen, if any was there, could be compared, as the precipitation of graphite and the amount of combined carbon present due the rate of cooling and other elements would definitely make the effect of the oxygen very obscure. In commercial irons, with the amount of silicon and manganese that was present, he would say it was very doubtful if any dissolved oxygen existed at all. This was more or less confirmed by Mr. Henshaw himself in what he said about the benefits of the Swedish Bessemer over the ordinary acid Bessemer, the former working with a higher manganese content.

MR. C. D. POLLARD remarked that the question of oxygen was very involved, and it really called for a trained metallurgist to discuss it. As a producer of castings, he would like to mention blowholes, and he asked Mr. Henshaw whether, during the rising of the small particles to which he had alluded, there was any hesitation in their rising which might result in their accumulation in the lower part of steel castings.

AUTHOR'S REPLY

MR. HENSHAW, replying to the points that had been raised, dealt first with Mr. Walker's question of the particles rising and yet being found in greater number at the bottom rather than at the top of the mould. It had to be remembered that they were pouring fine particles into an ingot, and must think of the surge that was caused. The particles would not necessarily descend in the order that they ascended. It all depended on the size of the particle. If they poured into an ingot mould from the top, the circulation was pretty severe. Supposing that the skin at the top of the side of an ingot mould was an inch thick, it would be much thicker at the bottom. At the top portion of the mould there would be a tendency for more of the particles to accumulate than at any other point. This might be due to two reasons: in the first place, it was because there had been a big surge, and, secondly, the crystals formed there. He did not know whether this was the true explanation, but suggested that it was quite likely. It was true, of course, that they could not eliminate oxygen altogether, and that they had to change its form. The whole art of steelmaking at present was to change the oxygen form into something that would be less harmful. The precaution it was possible to take was to get as little oxidation as possible, and, when they had it, to see that it did as little harm as possible. In regard to grain size, he thought the possible explanation was that the minute particles of alumina which formed might stop the grain growth. He thought that aluminium dissolved in the steel certainly exerted influence. The strange thing was that one could reach a point where grain growth restarted. He thought it likely that the very fine particles of alumina—almost sub-microscopical—must have a very considerable effect.

Sulphur to Sulphate

In regard to Mr. Walker's question about sulphur, there must be, so far as he could see, some interaction between the sulphides and some of the oxides present. It looked almost as if sulphates formed; at any rate, there was certainly a change of condition. This was why they found so many complications among the non-metallic materials, and he could appreciate that time might effect a change in them. He realised that this was quite a possibility, since sulphur was not a very stable element; it formed fresh compounds on very little provocation. In respect of the question raised by Mr. Green about oxygen becoming advantageous, he would like to refer again to the remark he (Mr. Henshaw) had made when he said that the question of oxygen was not the whole story. They might have two materials, one of them of a higher oxygen content than the other, and yet it might be a better material. They might take two irons, for instance—both charcoal irons—one made with the minimum amount of charcoal—that was to say, there had never been an excess of charcoal present—and the other with the maximum amount of charcoal present, which would contain more oxide and yet be a far better iron. There were other factors having an influence. They did not know exactly what the influence of the oxygen was when it was there in the dissolved state. They might get two irons, one of which had a much higher oxygen content than the other, but if it were made a different way, the whole circumstances and the whole history of it were thereby different. It might be found to be an infinitely better iron than the other, but this was not due to the oxygen. However, he still believed that the form of the oxygen present had an influence. One of the amazing things was the variety of analyses one obtained from the oxide productions.

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January 9th, 1936.

Mr. C..... said,

"I shall send on to you every time. Since we adopted your Blacking the skin of our castings has improved by 100 per cent. Our customers were the first to notice it."

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This Week's News in Brief

Trade Talk

THE BARROW HEMATITE STEEL COMPANY, LIMITED, has started a new acid-steel furnace with a weekly capacity of 700 tons.

THE FIRST ANNUAL STAFF DANCE of the Clyde Alloy Steel Company, Limited, was held last week in Jerviston House, Motherwell.

MESSRS. BARTRAM & SONS, LIMITED, of Sunderland, have booked an order for a vessel of 9,300 tons deadweight for Cardiff owners.

THE ANNUAL STAFF DANCE of Mitchell, Russell & Company, Limited, Chattan Foundry, Bonnybridge, was held in the Masonic Temple last week.

MESSRS. METROPOLITAN VICKERS ELECTRICAL COMPANY, LIMITED, have received a £1,500,000 contract for the electrification of sections of the Central Railway of Brazil.

THE LONDON & NORTH EASTERN RAILWAY COMPANY has placed an order with Messrs. Beyer Peacock & Company, Limited, Manchester, for 28 goods engines and tenders.

SIX HUNDRED GUESTS attended the annual dance of the staff society of Thos. Firth & John Brown, Limited, and Firth-Vickers Stainless Steels, Limited, in Sheffield.

THE BUSINESS OF J. Calderwood & Company, brassfounders, of 88, Wellington Lane, Glasgow, has been transferred to Mr. Robert Davidson, who will carry it on under the same name.

AS A RESULT of the receipt of seven marine-engine orders for ships to be built on Wearside, Messrs. George Clark, Limited, Southwick, Sunderland, have decided to reopen their boiler shops.

REPORTS FROM DERBYSHIRE show that there has been increased production by the local blast furnaces, following a demand for iron by the light-castings trade. Brassfounders also report good prospects for the present year.

FIRE BROKE OUT in the Rosebank Ironworks of James Mitchell & Son at Miller Street, Cambuslang, on February 21. The outbreak originated in the office, which was completely gutted. Arrangements have been made to carry on business as usual.

SUBJECT to the settlement of certain points of detail, the Admiralty has decided to entrust the construction of the general service submarine of the 1935 programme, H.M.S. "Triton," to Messrs. Vickers-Armstrong, Limited, of Barrow-in-Furness.

THE SHOTTS IRON COMPANY is rebuilding two blast furnaces for immediate operation. The company has two furnaces in blast, producing foundry pig-iron, and as the demand for Scottish pig-iron is increasing, the company intends to light up every workable furnace.

A CONTRACT FOR THE Diesel engines of two 14,000-ton oil tankers to be built at Wallsend by Messrs. Swan, Hunter & Wigham Richardson, Limited, for G. T. Bowring & Company, Limited, London, has been placed with J. G. Kincaid & Company, Limited, Glasgow.

THE PARK GATE IRON & STEEL COMPANY, LIMITED, has made a final call, due not later than March 31, of 2s. 6d. per share on the 500,000 shares at present 17s. 6d. paid. The directors also intend at the annual meeting to propose that the shares be converted into stock.

MESSRS. SIR W. G. ARMSTRONG, WHITWORTH & COMPANY (ENGINEERS), LIMITED, Newcastle, have received an order from the Western Australian Government Railways Administration for six 140-160-b.h.p. 3-ft. 6-in. gauge light railcars, each to accommodate 40 passengers.

THE BUDD INTERNATIONAL CORPORATION has disposed of its controlling interest in the Pressed Steel Company of Great Britain, Limited, to the British Pacific Trust, Limited, of London, and its associates. The controlling ownership of the company thus has passed into British hands.

ASSOCIATES OF THE Staffordshire Iron and Steel Institute visited the Fordath Engineering Company, Limited, at West Bromwich, on February 18, and were conducted round the works by members of the staff. The various methods of sand-testing and analytical methods used in the laboratory were explained to them by Mr. A. Tipper, B.Sc., chief chemist, and the manufacture of rotary core machines was seen in the machine shop.

SIR WILLIAM LARKE, speaking at a luncheon of the British Electrical and Allied Industries Research Association, said the Association was an outstanding example of the advantages of co-operative research. He appealed particularly for increased support to the mining interests, who were directly concerned with the researches into flame-proof enclosures for motors and switchgear; to shipbuilding interests and classification societies in connection with the work directed to the improvement of reliability and the control of heating in cables, the improvement in design of steam turbines, and the elimination of corrosion in condensers; and to the machinery insurance interests.

MESSRS. THOS. W. WARD, LIMITED, of Sheffield, who acquired the Laycock engineering works at Millhouses a few years ago, recently parted with the property to an independent company, the Laycock Engineering Company, Limited, on whose board their own directorate is represented. A farewell dinner was given by the chairman and directors of Messrs. Thos. W. Ward, Limited, to the staff of the Laycock company recently. Mr. Joseph Ward, who presided, said that when his firm took over Laycock's, five or six years ago, there was acute depression in the iron and steel trades and many engineering branches. When they took the works over, there were 240 staff and workmen. On the day they handed the company over to the new owners there were 700 people employed at the works. Mr. S. Walker, works manager of the Laycock Company, on behalf of the employees, presented to the directors of Messrs. Thos. W. Ward an illuminated address recording appreciation of their action in affording them, under their guidance, an opportunity of recovering the affairs of the company from the unfortunate position prevailing in December, 1930.

Personal

MR. W. G. PALLETT, formerly general manager of the Laycock Engineering Company, has been appointed managing director.

MR. MARK HODGSON, who has been chairman of the Executive Council for the past 13 years, has been appointed secretary of the United Society of Boilermakers and Iron and Steel Shipbuilders in succession to Mr. John Hill, who retires in March.

Wills

KITSON, F. J., of Leeds, Chairman of the Monk Bridge Iron & Steel Company, Limited, joint deputy-chairman of the Yorkshire Electric Power Company	£115,325

Obituary

MR. ROBERT WILLIS, who for nearly 50 years was associated with the business of W. C. Willis & Company, iron and steel merchants, Glasgow, died at Dunblane recently.

Contracts Open

Exeter, March 4.—Cast-iron pipes, miscellaneous iron castings. Mr. R. H. Dymond, city engineer, Municipal Offices.

Weymouth, March 9.—1,100 tons of vertically and/or centrifugally spun cast-iron pipes varying from 3 in. dia. to 30 in. dia., with various special castings. Messrs. M. G. and R. W. Weekes, civil engineers, 75, Victoria Street, Westminster, London, S.W.1. (Fee £5 5s., returnable.)

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

W. & H. Wilson, Limited.—Iron and brass workers, etc. Capital £10,000. Directors: W. A. Wilson, Beechwood, Shadwell Lane, Moortown, Leeds; H. F. Wilson.

Coventry Repetition Company, Limited, 11, Queen's Road, Coventry.—Mechanical engineers, etc. Capital £100. Directors: A. Green, C. N. Faulconbridge and C. N. Green.

Company Reports

Scottish Iron & Steel Company, Limited. — Final dividend of 5 per cent. on the ordinary shares, making 7 per cent. for year.

Thomas Robinson & Son, Limited.—Six months' dividend on account of arrears on 7½ per cent. preference shares, bringing dividends up to December 31, 1934.

Delta Metal Company, Limited.—Profit for 1935, £86,396; brought in, £13,034; dividend of 12½ per cent., tax free, and bonus of 12½ per cent., tax free, written off premises, plant and installation, £10,000; carried forward, £14,430.

James Booth & Company (1915), Limited.—Dividend of 15 per cent. on the ordinary shares for 1935. The directors propose to offer to ordinary shareholders at a premium of £1 a share, one new ordinary share for each five ordinary £1 shares held by them.

Lancashire Dynamo & Crypto, Limited.—Profit for the year, after charging £13,390 for depreciation and £18,114 for income tax, £34,763; brought in, £12,481; dividend on the cumulative preference shares at 5½ per cent. per annum, £2,557; dividend at 10 per cent. on the ordinary shares for the year, £20,150; to staff pension fund, £1,000; carried forward, £23,537. Meeting, February 27.

Mather & Platt, Limited.—Net profit, after charging depreciation, directors' remuneration, and making provision for doubtful debts, £178,017; balance of profit on realisation of investments, £14,328; special reserve account, £15,000; brought in, £39,655; preference dividend of 5 per cent., £20,000; dividend on the ordinary stock of 10 per cent., £136,366; carried forward, £60,635. The directors also recommend a distribution from special reserve account of 2 per cent. on the ordinary stock on account of realised capital profits, which will absorb £27,273. Meeting, February 25.

Forthcoming Events

MARCH 4.

Manchester Metallurgical Society :—"Fusion-Welded Pressure Vessels." A Paper by S. F. Dorey, D.Sc., at the Engineers' Club, Albert Square, Manchester, at 7 p.m.

MARCH 14.

Keighley Association of Engineers :—Annual Dinner, at the Queen's Hotel, Keighley; Reception at 5.45 p.m.

Institute of Metals

MARCH 5.

London Local Section :—"Patent Law—With Special Reference to Non-Ferrous Metals." A Paper by G. S. W. Marlow, B.Sc., at the Motor Manufacturers & Traders, Limited, 83, Pall Mall, London, S.W.1, at 7.30 p.m.

MARCH 9.

Scottish Local Section :—"Centrifugal Casting of Non-Ferrous Metals," Paper by F. W. Rowe, B.Sc., at the Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, at 7.30 p.m.

MARCH 11 AND 12.

The Annual General Meeting of the Institute, at the Institute of Mechanical Engineers, Storey's Gate, London, S.W.1, at 10 a.m.

MARCH 13.

Sheffield Local Section :—The Annual General Meeting will be held in the Non-Ferrous Section of the Applied Science Department of the University, St. George's Square, at 7.30 p.m.

Institute of British Foundrymen

FEBRUARY 29.

Scottish Branch :—"Foundry Coke," Paper by Prof. H. L. Riley, at Temperance Café, Lint Riggs, Falkirk, at 6 p.m.

MARCH 4.

Birmingham, Coventry and West Midlands Branch :—Works visit. "Applications of Pulverised Fuel," by H. E. Cookson, at Coventry.

London Branch :—"How to Reduce Coremaking Costs," Paper by N. P. Newman, at the Charing Cross Hotel, London, W.C.2, at 8 p.m.

MARCH 7.

East Midlands Branch :—Annual Dinner, held at Loughborough College, Loughborough, at 6 p.m.

Lincolnshire Section :—Students' Papers, at the Technical College, Mark's Road, Lincoln, at 7 p.m.

Lancashire Branch :—Ten-minute Papers, at the Engineers' Club, Albert Square, Manchester, at 4 p.m.

MARCH 10.

Burnley Section :—Annual General Meeting; "Influence of the Various Metalloids on Cast Iron," Paper by D. Malone, at the Municipal College, Ormerod Road, Burnley, at 7.15 p.m.

The Institute of Vitreous Enamellers

MARCH 5.

Manchester :—"Enamel Mill-room Practice and Equipment," Paper by G. Steele, at the Y.M.C.A., Peter Street, Manchester, at 7.30 p.m.

SAND MIXING AND HANDLING

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Engineering Skill and Foundry Technique have, during the past year or two, displayed a remarkable desire to marry for the benefit of the Foundry Industry.

The result is observable in the number of Foundry organisations which are bringing their production units up to date.

Much has already been done by way of modern layout and the installation of new plant, but it must be acknowledged that a vast amount of work still awaits execution.

This announcement will, we hope, remind you that we are well able and desirous of placing proposals for Modern Foundry Equipment before you.

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Raw Material Markets

Hopes are still being expressed that the production of Cleveland iron will be considerably increased in the near future, but no move has been made up to the present time. An additional blast furnace was lighted up last week, but the output will be absorbed by the local steelworks. Consumption of pig-iron is on a good scale and activity at the steelworks is also well maintained. All prices are very firm and some products have reached higher levels.

Pig-Iron

MIDDLESBROUGH. — Orders for Cleveland foundry iron are still having to be refused by local ironmasters. Another blast furnace is expected to be ready for the production of foundry pig in about three weeks' time. Deliveries are behind schedule. Nominal prices of No. 3 Cleveland G.M.B. are 70s. per ton delivered Middlesbrough or Falkirk, 72s. North-East Coast, and 73s. Glasgow.

The output of the eight blast furnaces producing hematite in this area is being fully absorbed, but supplies are sufficient to meet the present demand. There is very little material to spare, however, and the export trade is having to be neglected in some instances. Hematite makers are refusing to sell at below the recently increased prices, which are based on 77s. per ton for No. 1 grade delivered North-East Coast or Scotland. Most consumers are well covered for supplies and other would-be buyers prefer to await an official statement in regard to quotations.

LANCASHIRE.—Pig-iron is going into consumption in this area on a good scale and deliveries amount to a fairly substantial tonnage. Textile machinists are still poor consumers, but other sections of industry are pressing for heavy supplies. Machine-tool makers have good order-books, as also have the heavy electrical engineers. Local jobbing foundries are taking supplies on a good scale. For delivery to users in the Lancashire price zone, Derbyshire, Staffordshire and Lancashire brands of No. 3 foundry iron equal to Derbyshire are all quoted on the basis of 78s. per ton for delivery up to the end of June and 83s. for delivery after that date, with Northants on offer at 76s. 6d. and 81s. 6d. respectively. Scottish No. 3 is now quoted, for delivery to users in the Manchester area, at 87s. 6d. per ton, while East Coast hematite is quoted at 85s. and West Coast material at 85s. 6d., both delivered equal to Manchester.

MIDLANDS.—The bad weather of recent weeks has caused a slight falling off in the demand from the light-castings makers, but the output from the furnaces during February is expected to equal that of January, which was very satisfactory. Most producers are still asking for a premium of 5s. on iron bought for delivery in the second half of the year. Current prices are :—72s. 6d. per ton for Northants No. 3 and 75s. for Derbyshire, Lincolnshire and North Staffs No. 3, delivered Birmingham and Black Country stations and subject to a small sliding-scale rebate to large consumers. The demand for the better-quality irons continues to be satisfactory. Prices are not controlled, but are very firm. Medium-phosphorus iron is 77s. 6d. to 87s. 6d., low-phosphorus 90s. to 97s. 6d., and refined iron £6 7s. 6d. to £7 15s. per ton, delivered this district. Business in hematite has not been heavy since prices were raised, but most makers are well booked. Prices are controlled and for delivery to Birmingham and Black Country stations are £4 7s. 6d. for East Coast No. 3, £4 8s. 6d. for West Coast mixed numbers, and £4 7s. for Welsh mixed numbers, plus 1s. 6d. extra if delivered into works.

SCOTLAND.—Firm conditions continue to prevail in the Scottish market, but buying of iron is restricted by the unwillingness of sellers to commit themselves further at the present time. Prices are expected to be advanced in the near future. The official minimum of 74s. f.o.t. furnaces for No. 3 foundry is still quoted, with 2s. 6d. extra for No. 1. Difficulty is still being experienced among the light-castings makers in getting their requirements satisfied. No. 3 Cleveland foundry is still quoted at 70s. f.o.t. Falkirk and 73s. f.o.t. Glasgow, with other English foundry iron quoted at 1s. 3d. per ton below the foregoing figures. Steelworks are still very active. Mixed numbers of East Coast, West Coast and Scottish hematite continue to be quoted at 77s. at the steelworks. Basic iron, British and Indian, remains at 70s. (less 5s. rebate) f.o.t. steelworks. The latter price is expected to be raised in the near future.

Coke

Supplies of coke are available in increasingly larger tonnages, but quotations are still very firm. In some cases consumers have agreed to pay 1s. 6d. per ton on all contracts to help towards the cost of the increase in the miners' wages. For delivery to Birmingham and district, best Durham coke is quoted at 41s. 6d. to 43s., and Welsh coke from 38s. up to 50s. per ton.

Steel

Satisfactory conditions rule in the steel market, and the demand shows no signs of weakening, says the official report of the London Iron and Steel Exchange. In a few departments new business has been rather quiet lately, but this is due to the recent heavy buying by consumers, who in many cases have covered themselves for some time ahead in anticipation of an increase in prices. Business in semi-finished materials is only checked by the inability of the producers to accept further commitments. Although quotations were advanced recently, this has not brought much fresh material on to the market, and stringent conditions rule. Some relief, however, has been afforded as a result of the increased imports of Continental material. The producers of finished materials continue to make heavy deliveries to the consuming industries, and lately the prices for several descriptions of steel have been advanced. The strength of the home demand is unabated, but business on export account remains somewhat quiet.

Scrap

Increasing supplies of scrap material are having to be imported into the Cleveland area in order to cope with the heavy demand from consumers. Heavy melting steel is taken up immediately supplies become available, the basis price being 57s. 6d. per ton, delivered works, although up to 60s. has been paid. Machinery grade of heavy metal is at 65s. and ordinary foundry cast iron is at 60s. to 62s. 6d. Many consumers are unable to obtain their full requirements in the Midland market. Heavy machinery metal in handy sizes is at 60s. to 62s. 6d., good heavy at 55s. and clean light at 52s. 6d. Short, heavy steel scrap, as used in the foundries, is at 62s. 6d. to 65s. per ton, delivered works. Cast-iron and wrought-iron scrap are very strong sections of the Lancashire market and supplies are not being offered too freely. The price of wrought-iron scrap is 65s. per ton, and users are endeavouring to prevent any advance on this figure. Cast-iron scrap is offered at about 62s. 6d. delivered to Lancashire foundries, but supplies are restricted. Heavy melting steel scrap is quoted at from about 57s. 6d. to 60s. per ton, delivered Sheffield basis. There is a continuance of active conditions on the Scottish market, and all local and imported supplies are being readily absorbed. Heavy mild-steel melting scrap is receiving a heavy demand at 57s. 6d. per ton, with heavy basic or heavy iron and steel scrap mixed at about 5s. less. Machinery cast-iron remains around 70s. to 72s. 6d., delivered f.o.t. consumers' works.

Metals

Copper.—Active conditions have prevailed in this market recently. The consumptive demand in Europe has become larger than for some time past. Buying in the United Kingdom has been on a good scale and the armament programmes have caused active trading on the Continent. The British War Office has again been in the market for around 300 tons. In the United States buying has increased. World stocks of copper rose about 4,600 tons during January.

Daily market prices :—

Cash.—Thursday, £35 17s. 6d. to £35 18s. 9d.; Friday, £35 16s. 3d. to £35 17s. 6d.; Monday, £35 18s. 9d. to £36; Tuesday, £35 15s. to £35 17s. 6d.; Wednesday, £35 15s. to £35 17s. 6d.

Three Months.—Thursday, £36 3s. 9d. to £36 5s.; Friday, £36 1s. 3d. to £36 2s. 6d.; Monday, £36 6s. 3d. to £36 7s. 6d.; Tuesday, £36 2s. 6d. to £36 5s.; Wednesday, £36 2s. 6d. to £36 5s.

Tin.—The decision of the International Tin Committee to reduce the quota for the second quarter of this year to 85 per cent. has been received with much criticism. It is doubted whether world stocks will have attained a really adequate level by April. Industrial demand has been on a low scale in this country and conditions on the Continent have also been dull, but a considerable tonnage continues to be absorbed. Business in the United States continues to be on a moderate scale.

Metal Exchange quotations were as follow :—

Cash.—Thursday, £209 7s. 6d. to £209 12s. 6d.; Friday, £207 10s. to £208; Monday, £206 15s. to £207; Tuesday, £207 10s. to £207 15s.; Wednesday, £209 15s. to £210.

Three Months.—Thursday, £202 17s. 6d. to £203 2s. 6d.; Friday, £201 10s. to £202; Monday, £200 15s. to £201; Tuesday, £200 17s. 6d. to £201; Wednesday, £201 10s. to £201 15s.

Spelter.—There has been an improved demand for this metal during the past week, and the market shows quite a good tone. Quotations are maintained. The Société Générale de Belgique, in its annual report, states that the consumption of zinc has been satisfactory. The zinc industry in Belgium is active and every effort is being made to find new outlets and new uses for the metal.

Official quotations were as follow :—

Ordinary.—Thursday, £15 13s. 9d.; Friday, £15 15s.; Monday, £15 18s. 9d.; Tuesday, £15 15s.; Wednesday, £15 15s.

Lead.—A distinct revival in the demand from the building industry has been noticeable during the past few days, and the lead market has reacted favourably. Continental consumers are taking up large quantities for armament purposes. Supplies of lead are going into consumption freely in the United States, but new business is not plentiful.

Day-to-day quotations :—

Soft Foreign (Prompt).—Thursday, £16 12s. 6d.; Friday, £16 10s.; Monday, £16 8s. 9d.; Tuesday, £16 7s. 6d.; Wednesday, £16 5s.

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

438,112. SUPERHEATER COMPANY, LIMITED, HALL, F., and KIRKE, P. ST. G. Method of and means for forming sinuous metal tubes.

438,143. ALLGEMEINE ELEKTRICITÄTS-GES. Electrical welding machines.

438,179. VERVOORT, B. Iron-chromium alloys.

438,183. BERLIN-KARLSRUHER INDUSTRIE-WERKE AKT.-GES. Steel gas-bottle for high-pressures and process for its manufacture.

438,266. KRUPP GRUSONWERK AKT.-GES., F. Tilting device for rolling mills.

438,405. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Electric-arc welding apparatus.

438,414. WOLFRAM & MOLYBDAEN AKT.-GES. Manufacture of sintered hard alloys.

438,421. LLOYD, H. D. Chilling of steel rod.

438,462. BURLAND, F. G., WILLIAMS, D. D., and WILLIAMS, LIMITED, H. Fishplates for rail joints.

438,536. STOCK, H. A., and WILMOT, A. J. Apparatus for casting metals.

438,816. DAVIES, H. T. Protective treatment of metals and alloys.

438,955. WRIGHT'S ROPES, LIMITED, JENKIN, R. C. G., and OWEN, A. H. Wire ropes.

439,041. WAHLERT, E. H. Polishing device for the rolls of rolling mills.

439,045. TRIGGS, W. W. (Deutsche Edelstahlwerke Akt.-Ges.). Chromium-manganese steel alloy.

German Ferro-Silicon Resources

Imports into Germany of ferro-silicon in 1934 and 1935 and the steps being taken to manufacture this ferro-alloy in Germany to dispense with foreign imports are discussed in an article in "Metallwirtschaft."

CROSSING THE BORDER

and the penalty

YOU see there are many good Iron Founders in the Midlands, and in the South for that matter, who have a secret yearning to mould again with a genuine Scottish Rock Sand, such as perhaps they have once been used to. They like the heavy bond, the coarse grains, the high permeability . . . Others have never known such luxuries.

The trouble comes from not being able to move large chunks of mother-earth down South from the banks and braes without the penalty of spending a lot of money—a deplorable thought!

But the merrily tapping of wayside rocks with our little geological hammers and our love of digging holes have taken effect. We've discovered nature's bounty in a natural rock moulding sand within easy reach of *the Midlands.* (EUREKA!)

It is christened Tor Rock Sand, and we baptize it with just enough water in a painstaking mill to give a wonderfully plastic, coarse, cohesive sand—a moulder's delight.

The scientific fellows say it's like this:—

CHEMICAL ANALYSIS.

Silica	86·8 %
Ferric Oxide	1·43%
Alumina	7·6 %
Lime	·22%
Magnesia	·18%
Titanic Oxide	·18%
Alkalies	1·8 %
Loss on ignition	1·6 %

MECHANICAL ANALYSIS.

Very Coarse Sand (+ 1 mm) ..	16·5%
Coarse Sand (+·5 mm − 1 mm) ..	16·0%
Medium Sand (+ ·25 mm − ·5 mm)	11·0%
Fine Sand (+ ·1 mm − ·25 mm) ..	30·0%
Silt Grade (+ ·01 mm − ·1 mm) ..	7·0%
Clay Grade (− ·01 mm)	19·5%

which doesn't explain everything, but we will if you will write to us.

GENERAL REFRACTORIES
LIMITED
Genefax House, Sheffield

Telephone: Sheffield 31113 (6 lines).
Telegrams: "Genefax, Sheffield."

LONDON OFFICE:
Russell House, Adelphi, W.C.2.
Telephone: Temple Bar 7361.
Telegrams: "Genefax, Rand-London."

SCOTTISH OFFICE:
156, St. Vincent Street, Glasgow.
Telephone: 5250.
Telegrams: "Genefax, Glasgow."

SOUTH WALES OFFICE:
11, Wind Street Swansea.
Telephone: 3680.
Telegrams: "Genefax, Swansea."

and Branch Offices, Works and Agencies throughout the world.

RAW MATERIALS—PRICE LIST

(Wednesday, February 26, 1936)

COPPER

	£ s. d.
Standard cash	35 15 0
Three months	36 2 6
Electrolytic	40 0 0
Tough	38 10 0
Best selected	39 0 0
Sheets	68 0 0
India	50 0 0
Wire bars	40 7 6
Ingot bars	40 7 6
H.C. wire rods	44 0 0
Off. av. cash, Jan.	34 14 10⅞
Do., 3 mths., Jan.	35 2 10⅞
Do., Sttlmnt., Jan.	34 15 1½
Do., Electro, Jan.	39 0 3½
Do., B.S., Jan.	38 10 3½
Do., wire bars, Jan.	39 4 10½
Solid drawn tubes	10½d.
Brazed tubes	10½d.
Wire	6½d.

BRASS

Solid drawn tubes	9¾d.
Brazed tubes	11¾d.
Rods, drawn	8¾d.
Rods, extd. or rlld.	8d.
Sheets to 10 w.g.	8d.
Wire	7¾d.
Rolled metal	7½d.
Yellow metal rods	5d.
Do. 4 × 4 Squares	5¾d.
Do. 4 × 3 Sheets	5¾d.

TIN

	£ s. d.
Standard cash	209 15 0
Three months	201 10 0
English	209 15 0
Bars	210 15 0
Straits	212 5 0
Australian	209 15 0
Eastern	209 12 6
Banca	210 15 0
Off. av. cash, Jan.	209 18 9
Do., 3 mths., Jan.	201 9 0¾
Do., Sttlmt., Jan.	209 19 0

SPELTER

	£ s. d.
Ordinary	15 15 0
Remelted	14 5 0
Hard	12 15 0
Electro 99.9	17 17 6
English	16 15 0
India	13 15 0
Zinc dust	19 10 0
Zinc ashes	4 5 0
Off. aver., Jan.	14 12 0¾
Aver. spot, Jan.	14 9 9

LEAD

	£ s. d.
Soft foreign ppt.	16 5 0
Empire (nom.)	17 2 6
English	18 5 0
Off. average, Jan.	15 8 10⅞
Average spot, Jan.	15 7 11½

ALUMINIUM

Ingots	£100 to £105
Wire	1/3 to 1/4 lb.
Sheet and foil	1/2 to 1/4 lb.

ZINC SHEETS, &c.

	£ s. d.
Zinc sheets, English	24 0 0
Do., V.M. ex-whse.	25 5 0
Rods	28 0 0

ANTIMONY

	£ s. d. to £ s. d.
English	72 0 0 to 73 0 0
Chinese, ex-whse.	63 0 0
Crude, c.i.f.	32 0 0

QUICKSILVER

	£ s. d. to £ s. d.
Quicksilver	12 2 6 to 12 10 6

FERRO-ALLOYS AND STEEL-MAKING METALS

Ferro-silicon—	
25%	8 17 6
45/50%	12 15 0
75%	17 17 6
Ferro-vanadium—	
35/50%	12/8 lb. Va.
Ferro-molybdenum—	
70/75% carbon-free	4/6 lb. Mo.
Ferro-titanium—	
23/25% carbon-free	9d. lb.
Ferro-phosphorus, 20/25%	£21 0 0 to £22 0 0
Ferro-tungsten—	
80/85%	3/- lb.
Tungsten metal powder—	
98/99%	3/3 lb.
Ferro-chrome—	
2/4% car.	33 0 0
4/6% car.	21 15 0
6/8% car.	21 0 0
8/10% car.	21 0 0
Ferro-chrome—	
Max. 2% car.	33 10 0
Max. 1% car.	36 5 0
Max. 0.70% car.	37 5 0
70% carbon-free	9½d. lb.
Nickel—99.5/100%	£200 to £205
"F" nickel shot	£184 0 0
Ferro-cobalt, 98/99%	5/6 lb.
Metallic chromium—	
96/98%	2/5 lb.
Ferro-manganese (net)—	
76/80% loose	£10 15 0 to 11 5 0
76/80% packed	£11 15 0 to 12 5 0
76/80% export	(nom.) £9 15 0
Metallic manganese—	
94/96% carbon-free	1/3 lb.

Per ton unless otherwise stated.

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten	2s. 0d.
Finished bars, 18% tungsten	2s. 9d.

Per lb. net, d/d buyers' works.

Extras—	
Rounds and squares, 3 in. and over	4d. lb.
Rounds and squares, under ⅛ in. to ¼ in.	3d. lb.
Do., under ¼ in. to $\frac{7}{16}$ in.	1/- lb.
Flats, ¼ in. × ¼ in. to under 1 in. × ⅛ in.	3d. lb.
Do., under ¼ in. × ¼ in.	1/- lb.
Bevels of approved sizes and sections	6d. lb.

Bars cut to length, 10% extra.

SCRAP

	£ s. d. to £ s. d.
South Wales—	
Heavy steel	3 5 0 to 3 7 6
Mixed iron and steel	3 0 0 to 3 2 6
Heavy cast iron	2 17 6 to 2 18 6
Good machinery	3 2 6 to 3 5 0
Cleveland—	
Heavy steel	2 17 6 to 3 0 0
Steel turnings	2 0 0
Heavy cast iron	3 0 0 to 3 2 6
Heavy machinery	3 2 6 to 3 5 0
Midlands—	
Light cast-iron scrap	2 12 6
Heavy wrought iron	3 7 6 to 3 12 6
Steel turnings	2 2 6
Scotland—	
Heavy steel	2 17 6
Ordinary cast iron	3 5 0 to 3 7 6
Engineers' turnings	2 2 6
Cast-iron borings	1 17 6 to 2 0 0
Wrot-iron piling	3 8 9
Heavy machinery	3 10 0 to 3 12 6

London—Merchants' buying prices, delivered yard.

	£ s. d.
Copper (clean)	29 0 0
Brass	19 10 0
Lead (less usual draft)	14 10 0
Tea lead	10 10 0
Zinc	8 10 0
New aluminium cuttings	74 0 0
Braziery copper	27 0 0
Gunmetal	27 0 0
Hollow pewter	155 0 0
Shaped black pewter	120 0 0

PIG-IRON

N.E. Coast (d/d Tees-side area)—	
Foundry No. 1	72/6
,, No. 3	70/-
,, at Falkirk	70/-
,, at Glasgow	73/-
,, No. 4	69/-
Forge No. 4	69/-
Hematite No. 1	77/-
Hematite M/Nos.	76/6
N.W. Coast—	
Hem. M/Nos. d/d Glas.	77/-
,, d/d Birm.	88/6
Malleable iron d/d Birm.	119/-
Midlands (d/d Birmingham dist.)—	
Staffs No. 4 forge	71/-
,, No. 3 fdry.	75/-
Northants forge	68/6
,, fdry. No. 3	72/6
,, fdry. No. 1	75/6
Derbyshire forge	71/-
,, fdry. No. 3	75/-
,, fdry. No. 1	78/-
Scotland—	
Foundry, No. 1, f.o.t.	76/6
,, No. 3, f.o.t.	74/-
Hem. M/Nos. d/d	77/-
Sheffield (d/d district)—	
Derby forge	68/6
,, fdry. No. 3	72/6
Lincs forge	68/6
,, fdry. No. 3	72/6
W.C. hematite	90/-
Lancashire (d/d eq. Man.)—	
Derby fdry. No. 3	78/-
Staffs fdry. No. 3	78/-
Northants fdry. No. 3	76/6
Cleveland fdry. No. 3	78/-
Dalzell, No. 3 (special)	102/6 to 105/-
Glengarnock, No. 3	87/6
Clyde, No. 3	87/6
Monkland, No. 3	87/6
Summerlee, No. 3	87/6
Eglinton, No. 3	87/6
Gartsherrie, No. 3	87/6
Shotts, No. 3	87/6

FINISHED IRON AND STEEL

Usual district deliveries for iron; delivered consumer's station for steel.

Iron—	£ s. d. to £ s. d.
Bars (cr.)	10 2 6
Nut and bolt iron	8 10 0 to 9 0 0
Hoops	11 0 0 and up.
Marked bars (Staffs) f.o.t.	12 10 0
Gas strip	11 0 0 and up.
Bolts and nuts, ¾ in. × 4 in.	15 5 0 and up.
Steel—	
Plates, ship, etc.	8 15 0 to 8 17 6
Boiler plts.	9 5 0 to 9 7 6
Chequer plts.	10 7 6
Angles	8 7 6
Tees	9 7 6
Joists	8 15 0
Rounds and squares, 3 in. to 5½ in.	9 7 6
Rounds under 3 in. to ⅝ in. (Untested)	9 1 0
Flats—8 in. wide and over	8 12 6
,, under 8 in. and over 5 in.	8 17 6
Rails, heavy	8 5 0 to 8 10 0
Fishplates	12 10 0
Hoops (Staffs)	9 16 0
Black sheets, 24g. (4-t. lots)	11 10 0
Galv. cor. shts. (,,)	13 10 0
Galv. flat shts. (,,)	14 0 0
Galv. fencing wire, 8g. plain	15 0 0
Billets, soft	5 17 6 and up.
Billets, hard	6 17 6 to 7 2 6
Sheet bars	5 10 0 to 6 0 0
Tin bars	5 10 0 to 6 0 0

PHOSPHOR BRONZE

	Per lb. basis
Strip	10½d.
Sheet to 10 w.g.	11½d.
Wire	12½d.
Rods	11½d.
Tubes	14d.
Castings	12½d.

Delivery 3 cwt. free.
10% phos. cop. £30 above B.S.
15% phos. cop. £35 above B.S.
Phosphor tin (5%) £30 above price of English ingots.
C. CLIFFORD & SON, LIMITED.

NICKEL SILVER, &c.

	Per lb.
Ingots for raising	7d. to 1/1
Rolled—	
To 9 in. wide	1/1 to 1/7
To 12 in. wide	1/1½ to 1/7½
To 15 in. wide	1/1½ to 1/7½
To 18 in. wide	1/2 to 1/8
To 21 in. wide	1/2½ to 1/8½
To 25 in. wide	1/3 to 1/9
Ingots for spoons and forks	7d. to 1/3½
Ingots rolled to spoon size	10d. to 1/6½
Wire round—	
to 10g.	1/4½ to 1/11½

with extras according to gauge.
Special 5ths quality turning rods in straight lengths, 1/3½ upwards.

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated.

	Dols.
No. 2 foundry, Phila.	21.31
No. 2 foundry, Valley	19.50
No. 2 foundry, Birm.	15.50
Basic, Valley	19.00
Malleable, Valley	19.50
Grey forge, Valley	19.00
Ferro-mang. 80%, seaboard	75.00
O.-h. rails, h'y, at mill	36.37½
Billets	29.00
Sheet bars	30.00
Wire rods	40.00
	Cents.
Iron bars, Chicago	1.80
Steel bars	1.85
Tank plates	1.80
Beams, etc.	1.80
Skelp, grooved steel	1.80
Steel hoops	2.10
Sheets, black, No. 24	2.40
Sheets, galv., No. 24	3.10
Wire nails	2.40
Plain wire	2.30
Barbed wire, galv.	2.80
Tinplates, 100-lb. box	$5.25

COKE (at ovens)

Welsh foundry	26/6 to 32/6
,, furnace	20/6 to 21/6
Durham foundry	21/6 to 23/-
,, furnace	19/6 to 21/-
Scotland, foundry	30/-
,, furnace	26/-

TINPLATES

f.o.b. Bristol Channel ports.

I.C. cokes	20×14 per box	18/9 to 19/-
,,	28×20 ,,	37/6 to 38/-
,,	20×10 ,,	27/- to 28/-
,,	18⅞×14 ,,	19/6
C.W.	20×14 ,,	16/-
,,	28×20 ,,	34/-
,,	20×10 ,,	23/3
,,	18⅞×14 ,,	16/3

SWEDISH CHARCOAL IRON & STEEL

	£ s. d. to £ s. d.
Pig-iron	£6 0 0 to £7 0 0
Bars-hammered, basis	£16 0 0 to £16 10 0
Bars and nail-rods, rolled, basis	£15 15 0 to £16 0 0
Blooms	£10 0 0 to £12 0 0
Keg steel	£30 0 0 to £31 0 0
Faggot steel	£18 0 0 to £23 0 0
Bars and rods dead soft, st'l	£10 0 0 to £12 0 0

All per English ton, f.o.b. Gothenburg.
[Subject to an exchange basis of Kr. 18.16 to £1.]

DAILY FLUCTUATIONS

Standard Copper (cash)

	£ s. d.	
Feb. 20 ..	35 17 6 inc.	2/6
„ 21 ..	35 16 3 dec.	1/3
„ 24 ..	35 18 9 inc.	2/6
„ 25 ..	35 15 0 dec.	3/9
„ 26 ..	35 15 0 No	change

Electrolytic Copper

	£ s. d.	
Feb. 20 ..	40 0 0 No	change
„ 21 ..	40 0 0 „	„
„ 24 ..	40 0 0 „	„
„ 25 ..	40 0 0 „	„
„ 26 ..	40 0 0 „	„

Standard Tin (cash)

	£ s. d.	
Feb. 20 ..	209 7 6 inc.	37/6
„ 21 ..	207 10 0 dec.	37/6
„ 24 ..	206 15 0 „	15/–
„ 25 ..	207 10 0 inc.	15/–
„ 26 ..	209 15 0 „	45/–

Tin (English ingots)

	£ s. d.	
Feb. 20 ..	209 10 0 inc.	40/–
„ 21 ..	208 0 0 dec.	30/–
„ 24 ..	207 0 0 „	20/–
„ 25 ..	207 10 0 inc.	10/–
„ 26 ..	209 15 0 „	45/–

Spelter (ordinary)

	£ s. d.	
Feb. 20 ..	15 13 9 inc.	7/6
„ 21 ..	15 15 0 „	1/3
„ 24 ..	15 18 9 „	3/9
„ 25 ..	15 15 0 dec.	3/9
„ 26 ..	15 15 0 No	change

Spelter (Electro, 99.9 per cent.)

	£ s. d.	
Feb. 20 ..	17 17 6 inc.	10/–
„ 21 ..	17 18 9 „	1/3
„ 24 ..	18 1 3 „	2/6
„ 25 ..	17 17 6 dec.	3/9
„ 26 ..	17 17 6 No	change

Zinc Sheets (English)

	£ s. d.	
Feb. 20 ..	24 0 0 inc.	10/–
„ 21 ..	24 0 0 No	change
„ 24 ..	24 5 0 inc.	5/–
„ 25 ..	24 0 0 dec.	5/–
„ 26 ..	24 0 0 No	change

Lead (English)

	£ s. d.	
Feb. 20 ..	18 10 0 No	change
„ 21 ..	18 10 0 „	„
„ 24 ..	18 10 0 „	„
„ 25 ..	18 10 0 „	„
„ 26 ..	18 5 0 dec.	5/–

AVERAGE MONTHLY PRICES OF STEEL SHIP ANGLES (NORTH OF ENGLAND).

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1900	7 15 0	8 0 0	8 2 6	8 5 0	8 5 0	8 7 6	8 7 6	8 2 6	8 2 6	8 0 0	7 10 0	7 10 0	8 0 7½
1901	6 15 0	6 12 6	6 5 0	6 0 0	6 0 0	5 10 0	5 15 0	5 17 6	6 0 0	5 17 6	5 17 6	5 15 0	6 0 5
1902	5 12 6	5 10 0	5 10 0	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 11 8
1903	5 6 3	5 6 3	5 7 6	5 12 6	5 12 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 0 0	5 8 9
1904	5 0 0	4 17 6	5 2 6	5 5 0	5 5 0	5 5 0	5 5 0	5 5 0	5 0 0	5 0 0	5 0 0	5 5 0	5 2 6
1905	5 5 0	5 7 6	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 10 0	5 12 6	6 2 6	6 12 6	6 12 6	5 14 4½
1906	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	6 12 6	7 2 6	6 13 4
1907	6 17 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	7 2 6	6 12 6	6 12 6	6 12 6	7 0 5
1908	6 2 6	6 2 6	6 2 6	5 17 6	5 17 6	5 17 6	5 17 6	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 16 3
1909	5 12 6	5 12 6	5 12 6	5 12 6	5 12 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 7 6	5 9 7
1910	5 16 3	5 17 6	5 17 6	6 1 6	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	6 7 6	6 7 6	6 7 6	6 2 3½
1911	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 7 6	6 9 0	6 7 8½
1912	6 16 3	6 17 6	6 17 6	7 5 0	7 7 6	7 7 6	7 7 6	7 12 6	7 12 6	7 12 6	7 14 6	7 17 6	7 7 4½
1913	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 11 6	7 7 6	6 15 6	6 7 6	6 2 6	7 8 11½
1914	6 2 6	6 2 6	6 2 6	6 2 6	6 2 6	5 15 0	5 15 0	6 15 0	7 0 0	7 0 0	7 1 3	7 5 0	6 8 7½
1915	7 17 0	8 5 0	8 17 6	9 5 0	9 5 0	9 15 0	9 15 0	9 15 0	9 15 0	9 15 0	10 15 0	10 15 0	9 8 3½
1916	11 3 1½	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1917	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6
1918	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6	11 2 6½
1919	11 2 6	13 12 6	13 12 6	13 12 6	17 2 6	17 1 3	17 0 0	17 15 0	17 15 0	17 15 0	17 17 6	18 5 0	16 1 9
1920	10 10 0	20 0 0	21 10 0	22 0 0	23 5 0	24 0 0	24 0 0	24 0 0	24 15 0	24 10 0	24 0 0	24 0 0	22 19 2
1921	22 10 0	20 12 6	19 0 0	17 10 0	17 10 0	16 6 0	14 10 0	14 3 4	13 10 0	11 15 0	10 0 0	9 12 6	15 11 7
1922	9 17 6	10 0 0	10 0 0	10 0 0	10 0 0	9 17 6	9 10 0	8 15 7½	8 14 0	8 12 6	8 12 6	8 12 6	9 7 8½
1923	8 18 1½	9 1 3	9 14 0	10 0 0	10 0 0	10 0 0	9 8 9	9 9 6	9 10 0	9 8 9	9 11 6	9 18 9	9 11 8½
1924	10 0 0	9 18 1½	9 17 6	9 17 6	9 17 2	9 11 3	9 15 0	9 15 0	9 9 4½	9 6 6	9 5 0	9 5 0	9 13 1½
1925	9 2 0	9 0 11½	9 0 0	8 15 9	8 10 3½	8 9 0½	8 6 3	8 2 6	7 19 0½	7 12 3	7 5 0	7 2 6	8 5 5½
1926	7 2 6	7 2 6	7 3 4	7 3 4	7 2 6	7 3 9	7 7 6	7 8 6½	7 9 0	7 12 6	7 16 3	8 0 6	7 7 7½
1927	7 18 9	7 17 6	7 17 6	7 14 8½	7 13 9	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 12 6	7 14 1½
1928	7 12 6	7 14 9	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 17 6	7 16 10½
1929	7 17 6	7 17 6	7 17 6	7 17 6	8 0 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 5 0	8 0 10½
1930	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1931	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1935	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6

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Any employer wishing to communicate with a candidate should write to the General Secretary, quoting identification number.

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AGENCY

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